



Transport
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TP 5474E

TDC

Operational Plan

1991-92 to 1993-94

September 1991

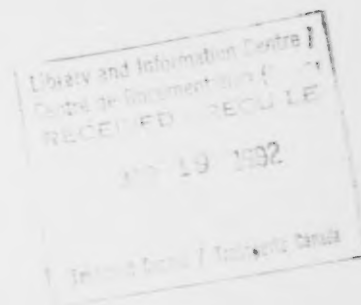
Canada

Transportation Development Centre
POLICY AND COORDINATION



TP 5474E

**TDC Operational Plan
1991-92 to 1993-94**



**Transportation Development Centre
Policy and Coordination
Transport Canada**

September 1991

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ACRONYMS & ABBREVIATIONS

ABS	Antilock Braking System
ADES	Airspace Design Expert System
ADMP	Assistant Deputy Minister, Policy and Coordination
ATC	Air Traffic Control
ATCS	Advanced Train Control Systems
AVC	Automatic Vehicle Classification
AVI	Automatic Vehicle Identification
BLEVE	Boiling Liquid Expanding Vapour Explosion
CASI	Canadian Aeronautics and Space Institute
CASPPR	Canadian Arctic Shipping Pollution Prevention Regulations
CCG	Canadian Coast Guard
CCPA	Canadian Chemical Producers Association
CRC	Communications Research Centre
CSA	Canadian Standards Association
CTR	Civil Tilt-Rotor
CUTA	Canadian Urban Transit Association
DGRD	Research and Development Directorate
EEG	Electroencephalograph
ELT	Emergency Locator Transmitter
EMAT	Electro-Magnetic Acoustic Transducer
ERDA	Economic and Regional Development Agreement
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
G&C	Grants and Contributions
GPS	Global Positioning System
HELP	Heavy Vehicle Electronic Licence Plate Program
ICAO	International Civil Aviation Organization
IITRI	Illinois Institute of Technology Research Institute
IMO	International Marine Organization
ISTC	Industry, Science and Technology Canada
IVHS	Intelligent Vehicle-Highway System
MAB	Marine Advisory Board
MEG	Magnetoencephalograph
MLS	Microwave Landing System
MMIC	Monolithic Microwave Integrated Circuits
NASA	National Aeronautics and Space Administration
NRC	National Research Council Canada

NSS	National Secretariat for Search and Rescue
O&M	Operations and Maintenance
PERD	Panel on Energy Research and Development
R&D	Research and Development
RFP	Request for Proposals
RRAB	Railway Research Advisory Board
SAR	Synthetic Aperture Radar
SINADS	Shipboard Integrated Navigation and Display System
SINSS	Shipboard Integrated Navigation Support System
TAC	Transportation Association of Canada
TC	Transport Canada
TDC	Transportation Development Centre
TDPP	Transportation for Disabled Persons Program
TIES	Technical Investigation and Engineering Services
VTs	Vessel Traffic Services
WIM	Weigh-In-Motion



1. PROGRAM DIRECTION AND PLANNING PROCESS

1.1 Introduction

This document presents the operational plan of the Transportation Development Centre (TDC) with respect to the implementation of the Central R&D Program for fiscal year 1991-92, and the outlook for the program in 1992-93 and 1993-94. It is divided into three parts:

- An overview of TDC's role and responsibilities, followed by outlines of Transport Canada's R&D Policy and of the planning and implementation of the Central R&D Program;
- A description of the Central R&D Program over the next three years;
- A detailed description of the program for the current planning year, including project targets.

The plan's emphasis on sustained, long-term technological R&D is intended to enable Transport Canada to meet future transportation challenges while adhering to the government's program of budgetary restraint. These challenges include the provision of new transportation services, improved safety and security, environmental protection, and economic and regional development.

Technological innovation, fostered by TDC's R&D program, is a key element in meeting these challenges in a period of constrained personnel resources and reduced budgets.

1.2 TDC's Role and Responsibilities

A component of the Research and Development Directorate of the Policy and Coordination Group, TDC is Transport Canada's centre of excellence for transportation technology and innovation, providing a core of technological expertise and R&D project management capability.

Organized into five research divisions, TDC's staff of engineers, ergonomists, planners, and economists are responsible for formulating, managing, and reporting on projects concerning all transportation modes and all stages of the innovation cycle — from concept development to demonstration and deployment. These projects are contracted to a variety of organizations, mostly in the private sector.

TDC maintains close working relations with the transportation community to ensure the most efficient use of R&D resources, and the successful transfer and deployment of the results of its R&D program to benefit the nation's transportation systems.

1.3 R&D Policy

To support its commitment to science and technology, the federal government adopted a National Science and Technology Policy and set up InnovAction Strategy and the Prime Minister's National Advisory Board on Science and Technology in 1988. The policies resulting from these initiatives are translated into Transport Canada's R&D policy, as defined in DM Circular 88-04701-123 (TP 100, February 1988). The policy sets out the role, responsibilities, and general objectives of R&D and makes a sustained commitment to a Core R&D Program to meet the department's and the transportation sector's needs for technological innovation. The Core R&D Program is defined as: long-term applications R&D to support departmental needs; R&D to support the transportation sector; and exploratory R&D into emerging technologies.

Responsibility for the Core R&D Program lies with the Assistant Deputy Minister, Policy and Coordination (ADMPC) through the Director General, Research and Development (DGRD). The program is implemented by TDC.

TDC's operational plan is developed in accordance with the R&D policy:

- Guidance is provided by an R&D Council chaired by DGRD and made up of twelve representatives from TDC and Transport Canada's operating groups.
- The program's technical direction is developed in accordance with the *Central R&D Program Planning Guidelines* (TP 9494) issued annually by DGRD. These guidelines, in turn, reflect departmental concerns and priorities as outlined in *Corporate Directions* (TP 10097).
- The planning horizon is three years.
- Breakdowns are provided of the three Core R&D Program areas — long-term applications R&D, sector-directed R&D and exploratory R&D.
- The plan is structured to facilitate linkages with Transport Canada operating groups and to highlight, under multimodal R&D, long-term generic research common to all transportation modes.

1.4 Central R&D Program

While the Core R&D Program described above forms the principal part of the Central R&D Program implemented by TDC, the Centre is also involved in research activities resulting from R&D initiatives in specific areas. TDC's current program includes research projects funded by the following special controlled allotments:

- the federal Energy Research and Development Program administered by the Panel on Energy Research and Development (PERD);
- the Artificial Intelligence R&D program administered by Industry, Science and Technology (ISTC);
- the R&D component of the department's Transportation for Disabled Persons Program (TDPP); and
- research activities supported by the Canada/Quebec Economic and Regional Development Agreement (ERDA).

In addition, the Central R&D Program includes joint or cost-shared projects with funding and in-kind contributions from other Transport Canada sources, other federal departments and agencies, provinces, and industry. The current program includes projects to be carried out under the aegis of the Ontario Memorandum of Understanding; cooperative projects with the provinces of Quebec, Alberta, and British Columbia; and joint activities with industry associations, such as the Transportation Association of Canada (TAC) and the Canadian Urban Transit Association (CUTA).

1.5 R&D Planning Guidelines

The *Central R&D Program Planning Guidelines FY 1991-92* were issued in April 1991 after approval by the R&D Council. The *Guidelines* set out the objectives, thrusts, and priorities for TDC's multi-year R&D program and provide a framework for strategic and operational planning. They also prescribe procedures for holding consultations and measuring program accomplishments.

The direction of the Central R&D Program is derived from related federal and departmental priorities and policies as outlined in *Corporate Directions 1991*. Current strategic objectives addressed by the Central R&D Program are:

- safety and security of the transportation system;
- effectiveness in meeting transportation needs at least cost;
- efficiency of departmental operations and of the transportation system; and
- protection of the physical environment from the impact of the transportation system.

The *Guidelines* for FY 1991-92 specify that the Central R&D Program's highest priority will be support of departmental operations (long-term applications R&D) and strategic policy objectives (sector-directed R&D). Activities relating to technology monitoring and assessment (exploratory R&D) and technology transfer will be accommodated where resource and scheduling constraints permit. Specific thrusts or "product lines" for R&D activities and projects for the planning period are listed in Table 1.1.

Table 1.1
R&D PROGRAM THRUSTS FOR PLANNING PERIOD

LONG-TERM APPLICATIONS R&D	GROUP	THRUSTS
	Aviation	• Flight Safety • Air Navigation Systems
	Airports	• Environmental Protection • Operation Planning Models
	Security	• Explosive/Weapon Detection
	Marine	• Environmental Protection • Marine Safety • Search and Rescue • Ship Performance in Ice • Marine Navigation • Ship Automation
	Surface	• Transport of Dangerous Goods Safety • Heavy Motor Vehicle Safety • Rail Safety
SECTOR-DIRECTED R&D	PROGRAM	THRUSTS
	Energy/Environment	• Efficient Use/Emissions • Alternative Fuels/Emissions • Transport Oil/Gas/Coal/Environmental Protection
	Accessible Transportation	• Vehicle/System Access • Traveller Safety • Communication/Orientation/Technical Aids
	Road Cooperative R&D (with TAC and CUTA*)	• Infrastructure Technology • Truck Technology • Intercity Bus Technology • Advanced Vehicle/Highway • Urban Transit Technology
	Rail Cooperative R&D (with RRAB*)	• Technology Assessments (e.g. safety, environment)
	Marine Cooperative R&D (with MAB*)	• Technology Assessments (e.g. Arctic marine)
	Aviation Cooperative R&D (with CASI*)	• Technology Assessments (e.g. deicing fluids)
	Regional Development	• Canada/Quebec ERDA (to October 1991)

* Refer to Acronyms & Abbreviations on page viii for full names of associations.

Table 1.1
R&D PROGRAM THRUSTS FOR PLANNING PERIOD (cont'd)

EXPLORATORY R&D	TECHNOLOGY	THRUSTS
	Artificial Intelligence	• Knowledge Based/Expert Systems • Voice Recognition • Neural Networks
	Micro-electronics	• Monolithic Microwave Integrated Circuits • Satellite Based Location/Navigation/Communication
	Advanced Materials	• Transport Applications • Non-destructive Testing
	Human Factors	• Ergonomics/Fatigue/Operator Interface
	Biotechnology	• Waste/Oil Degradation

Areas of high priority include:

- flight safety
- air navigation systems
- civil aviation security
- motor vehicle safety
- marine safety
- rail safety
- protection of the environment (e.g. transport of dangerous goods, marine oil spill containment/cleanup, vehicle emissions)
- accessibility for elderly and disabled persons
- human factors R&D

This operational plan describes Central R&D Program initiatives on the above priorities. TDC plays the principal role in program delivery with the Ottawa-based component of the Research and Development Directorate undertaking various activities relating to technology monitoring and the organization of workshops and seminars.

1.6 Program Planning, Implementation, and Evaluation

The iterative process of planning, implementing, and managing the Central R&D Program is illustrated in Figure 1.1. The following sections briefly describe each stage of this process.

1.6.1 Program Planning

Planning and approval, beginning with the *Guidelines* and ending with an approved operational plan, is normally carried out between August of one year and March of the subsequent year. The 1991-92 planning process, however, was delayed as a result of budget re-allocations necessitated by departmental funding cutbacks. The planning process encompasses the following activities:

- request for input on Guidelines (August-September);
- consultation with R&D clients (August-November);
- planning review (November);
- preparation of the draft plan (normally completed in December, but this year in the following June); and
- review and approval (normally from December to March, but this year in September).

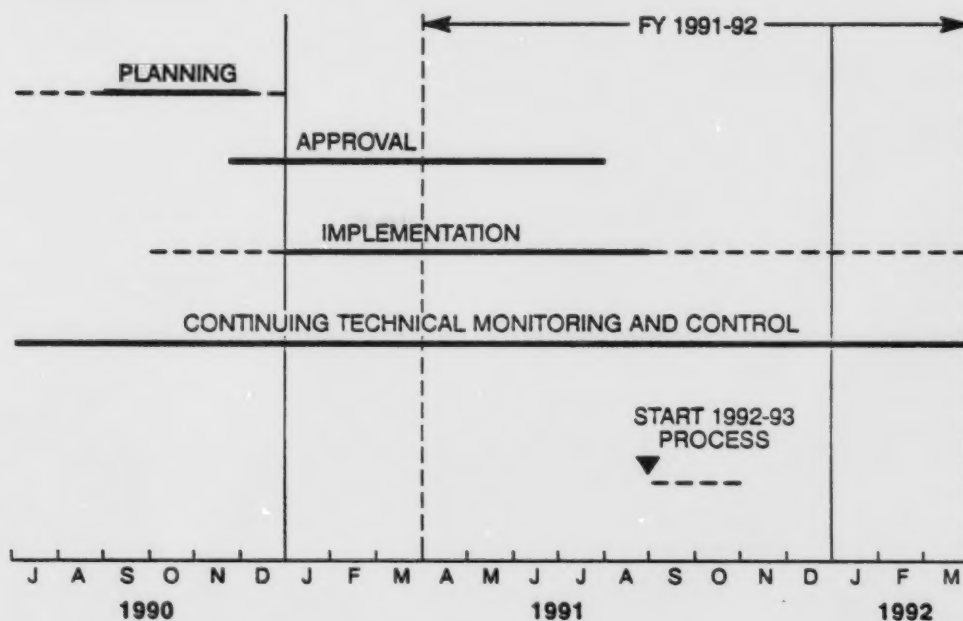
Planning for 1992-93 is scheduled to begin in September 1991.

1.6.2 Planning Inputs

In addition to the strategic objectives taken from *Corporate Directions* and the advice provided by the R&D Council, the concerns of the operating groups, special program sponsors, and the private sector are taken into account.

Operating Group Consultations: While the Council advises on the general direction of the R&D program, detailed planning of the program elements is carried out through extensive consultation with Transport Canada's operating groups. Meetings are held with each Director General to review the results of the previous year's activities, discuss the plans of the operating groups, and identify proposed new R&D activities. TDC reviews this information in the context of all other inputs and the limits of available resources and develops a draft plan, which is reviewed with each group head before being finalized.

Figure 1.1
R&D PROGRAM PLANNING, IMPLEMENTATION, & MANAGEMENT



Special R&D Initiatives: Consultations are held with the administrators of special R&D programs and initiatives to ensure that the research activities undertaken in each case correspond to the objectives of the agreement under which the funding or the R&D collaboration has been established.

Private Sector Inputs: Input from the private sector is obtained principally through R&D advisory boards dealing with marine, air, highway, and rail transportation, as well as with transportation accessibility. These boards meet periodically to discuss R&D issues, provide input to the R&D plans, and review these plans from the perspective of the private sector.

Further private sector input is received throughout the year in the form of unsolicited proposals for research projects. If the proposals meet the selection criteria (see section 1.6.3), and if sufficient funding is available, they are incorporated into TDC's program.

Seminars and conferences organized by the Research and Development Directorate and other agencies also provide valuable input that helps to determine the course of technical work.

1.6.3 Project Selection

Through the process of planning and consultation, a list of potential projects is developed. Criteria reflecting Transport Canada's R&D policy, recommendations of the R&D Council, directions from ADMPC, and results of the above consultations are used to select projects for implementation.

The criteria include:

- Contribution to achievement of the government and departmental objectives outlined in *Corporate Directions* and in the *Guidelines*.
- Responsiveness to the needs and priorities of the department and the Canadian transportation system. Priority is given to projects that offer technological opportunities to resolve a specific problem or provide significant economic or social benefits.
- Responsiveness to priorities defined under special programs. Projects relating to energy R&D, for example, are screened by committees of the Panel on Energy Research and Development and submitted to the Panel for yearly confirmation.
- Compatibility with existing program thrusts and activities.
- General value, feasibility, and implementation considerations. All projects are evaluated in terms of technical merit and risk, technology transfer, techno-economic considerations, potential for commercialization, involvement of interest groups, need for federal participation, and implementation factors such as the funding, management, and phasing of developmental activities.

The workload limits of TDC's personnel, as well as their areas of expertise, also govern the number and types of projects selected.

1.6.4 Project Implementation and Management

Implementation of the projects selected for inclusion in the R&D program for the planning year begins in January with the preparation of an Implementation Plan. This plan defines the human and financial resources assigned to each research activity. In addition, every quarter TDC reviews the list of proposed projects to determine whether changing circumstances make it possible to initiate new activities.

Implementation of projects then involves contracting out the project work using one of two contracting procedures:

- the competitive process whereby TDC initiates Requests for Proposals (RFPs) that are issued by Supply and Services Canada to prospective contractors. A contractor is selected and a contract awarded on the basis of an evaluation of proposals submitted in response to the RFP.
- the sole source process whereby a contract is awarded to an organization shown to be uniquely qualified to do the work.

Once a contract is in place, the TDC project officer is responsible for managing the project, which involves the following activities:

- directing projects toward their stated goal, including evaluating progress of work at key milestones and providing technical advice;
- providing feedback to and from contractors and R&D clients;
- providing financial control.

Project completion consists of evaluating the contractor's work, the outcome of the research, and the resulting recommendations; reviewing the research report; and finally, ensuring that the results are disseminated and utilized.

1.6.5 Program Evaluation

TDC monitors the performance of the Central R&D Program on a continuous basis, using a number of criteria: achievement of operational plan targets; contribution to departmental priorities; comments and feedback from the operating groups and other R&D clients; applications or innovations introduced; patents and licences registered; awards received; contributions to scientific and technological knowledge; and industrial spin-offs.

In addition, the Centre publishes an *Annual Review* (TP 3230) that records the past year's activities and periodically produces *Selected R&D Achievements* (TP 8785), which tracks the long-term effects of TDC's R&D program and documents its tangible benefits.

A departmental evaluation of the Program, as required by the R&D Policy, is under way and is expected to be completed in fall 1991.

1.7 Program Organization

TDC's operational plan for the delivery of the Central R&D Program is organized into the following areas:

- marine
- air
- highway
- rail
- transportation accessibility
- multimodal
- R&D support

The three-year R&D thrusts of each program area are discussed in Part 2 of this document. In Part 3, each program area is defined in terms of objectives and sub-objectives. Levels of attainment expected in 1991-92 are qualified through target statements and through resources assigned.

Because of its special terms and conditions, the Canada/Quebec Economic and Regional Development Agreement is treated as a distinct program area and described in separate chapters in Parts 2 and 3. However, specific projects are described in the program areas listed above.

1.8 Program Resources

The level of R&D activity reflected in TDC's operational plan is based on the resources available in the fiscal year and on estimates of expenditures possible with the human resources available. In 1991-92, TDC has been allotted a total of 38 person-years, compared with 40 for the previous fiscal year. TDC's base budget of Core R&D funds for 1991-92 is \$7.06 million, compared with last year's \$8 million and the \$9 million stipulated in the R&D Policy. The Core funding cutbacks are due to an anticipated shortfall in the department's operating revenues this year as well as to continuing federal fiscal restraint directives. The departmental evaluation of the Central R&D Program is expected to address funding mechanisms and commitments.

TDC's base budget of Core funding is augmented by funds from the following sources in 1991-92:

- The Energy Research and Development Program — \$2.4 million, down approximately \$500 000 from last year;

- TDPP — \$230 000; these funds, reduced by \$570 000 this year, will be augmented by Core funding.
- Other Transport Canada components, other federal departments, provinces and other sources — about \$2.6 million of additional funding.

Together these bring TDC's total O&M budget to an estimated \$12.3 million. Grants and Contributions — \$700 000 from Canada/Quebec ERDA and \$100 000 from TDPP — bring the total level of TDC-managed funds to \$13.1 million.

TDC-managed funds are further levered by the Centre's R&D partners in the public and private sectors through expenditures and in-kind contributions for joint projects and programs. Estimated at \$7 million, these contributions make the total value of the R&D program approximately \$20 million for 1991-92.

Normally, a degree of flexibility is built into the plan by keeping some resources uncommitted, so that TDC can undertake additional R&D activities should new opportunities arise. This year, however, because of severe budget cutbacks, all funds are fully committed in the air and transportation accessibility areas, and very little leeway remains in the others.

The funding sources for TDC's 1991-92 R&D budget are listed in Table 1.2, which also includes figures from the previous year and from the 1988 R&D Policy statement.

The tables and figures on the following pages present an analysis of TDC's program in terms of funding and structure. Table 1.3 gives an overview of the resource requirements and funding sources by program area for 1991-92 and Table 1.4 summarizes the program requirements for 1992-93 and 1993-94. The breakdown of federal funding by R&D category is illustrated in Figure 1.2. The structure of TDC's research program and the breakdown by funding area are illustrated on Figures 1.3 and 1.4 respectively.

Table 1.2
FUNDING OF TDC's R&D PROGRAM 1990-91, 1991-92

R&D FUNDING SOURCES	1988 DM CIRCULAR R&D POLICY	1990-91	1991-92
		\$000	
TDC BASE BUDGET (CORE)	9 000	8 000	7 060
Core R&D		7 650	6 900
ISTC Artificial Intelligence R&D Fund		350	160
OTHER O&M FUNDS		6 500	5 260
Energy Research and Development Program		2 970	2 430
Transportation for Disabled Persons Program (TDPP)		800	230
Other Transport Canada Components		2 000	2 040
Other Departments		450	360
Other Sources		280	200
Sub-total		14 500	12 320
GRANTS AND CONTRIBUTIONS		900	800
Transportation for Disabled Persons Program		100	100
Canada-Quebec Economic and Regional Development Agreement		800	700
Sub-total		15 400	13 120
ADDITIONAL CONTRIBUTIONS		8 000	7 000
TOTAL PROGRAM LEVEL		23 400	20 120

Table 1.3
FUNDING ESTIMATES AND SOURCES*, 1991-92

R&D PROGRAM AREAS	RESOURCE ESTIMATES TOTAL \$000	FUNDING SOURCES (\$000)				
		TDC	TDPP	ENERGY	TC	OTHER
MARINE	3 480	1 530	—	650	1 260	40
AIR	3 030	2 060	—	400	540	30
HIGHWAY	2 200	1 000	—	740	90	370
RAIL	1 220	800	—	270	150	—
TRANSPORTATION ACCESSIBILITY	860	530	230	—	—	100
MULTIMODAL	850	570	—	270	—	10
R&D SUPPORT	680	570	—	100	—	10
TOTAL	12 320	7 060	230	2 430	2 040	560

* Based on O&M funds totalling \$12.3 million. Excludes Grants and Contributions and Additional Contributions.

Table 1.4
R&D FUNDING REQUIREMENTS, 1992-93 and 1993-94

R&D PROGRAM AREAS	FY 1992-93 \$000	FY 1993-94 \$000
MARINE	4 000	4 000
AIR	4 000	4 000
HIGHWAY	2 800	2 800
RAIL	1 250	1 300
TRANSPORTATION ACCESSIBILITY	1 000	950
MULTIMODAL	1 200	1 300
R&D SUPPORT	1 100	1 200
TOTAL	15 350	15 550

Figure 1.2
FUNDING* BY R&D CATEGORY, 1991-92

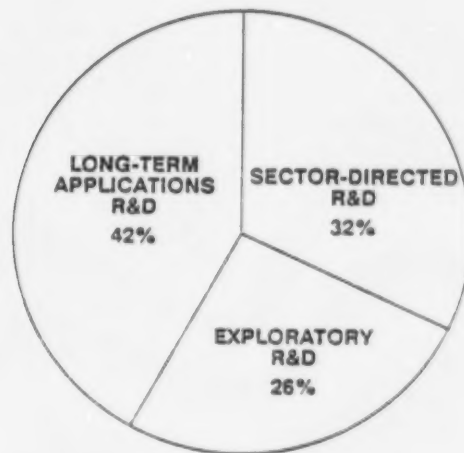
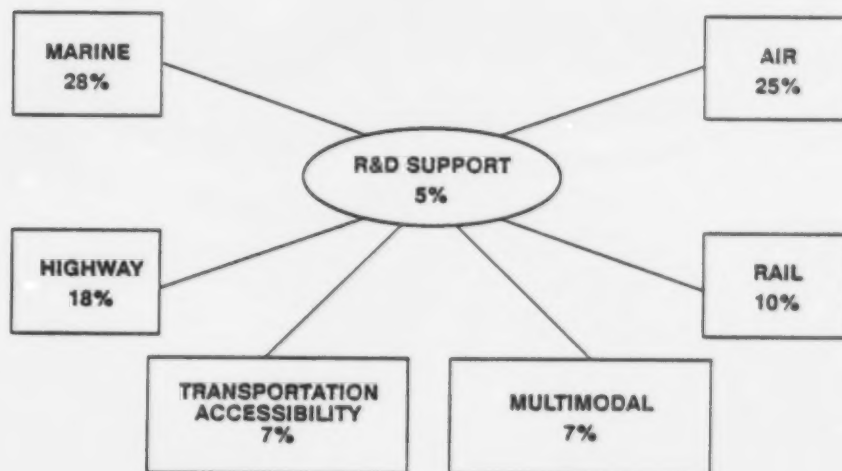
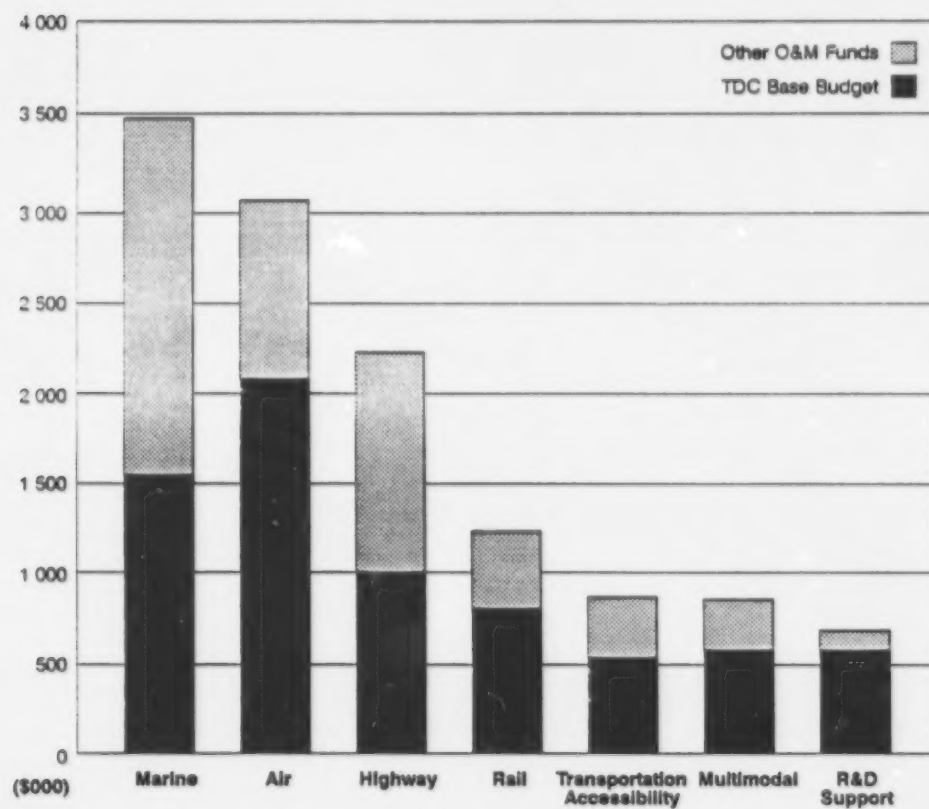


Figure 1.3
PROGRAM STRUCTURE AND FUNDING*, 1991-92



* See note on page 13.

Figure 1.4
FUNDING* BY PROGRAM AREA, 1991-92



* See note on page 13.







2. THREE-YEAR R&D THRUSTS (1991-92 to 1993-94)

The following descriptions of R&D program activity reflect a three-year R&D thrust for each area. They are meant to convey an understanding of TDC's long-term goals and the need for endorsement of these goals so that funds are made available for specific R&D projects as opportunities arise.

2.1 Marine R&D Program

The central focus of TDC's marine technology R&D program is the improved design, regulation, and safe operation of vessels in Canadian waters. The program currently emphasizes the development of technologies aimed at making shipping safer in ice-bound and open waters. Its second and equally important focus is the evaluation of new products and systems in support of the Canadian Coast Guard (CCG).

The framework of objectives and sub-objectives for the marine R&D program is presented in Table 2.1. The planned R&D activity corresponding with each of these objectives and sub-objectives is described below.

Close to half of the funding for this program component comes from TDC Core R&D funds. The balance comes from other divisions of Transport Canada (mainly the CCG) and from the Energy Research and Development Program. The latter sponsors technological research in support of applications and transportation of energy commodities. Table 2.2 shows the planned activity levels for 1991-92 and the targeted levels for 1992-93 and 1993-94 for the marine program.

2.1.1 Regulation and Safety

Transport Canada's prime function in marine regulation and safety is to ensure that the marine transportation system is as safe as possible. This R&D program directly supports the Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR), which protect Canada's sensitive northern ecosystem, and provides valuable data to support the Canadian position on International Marine Organization (IMO) regulations. The regulatory regime must strike a balance between protecting the northern environment and facilitating commercial operations in the Arctic.

The regulation and safety program addresses Arctic and conventional ships, search and rescue, marine safety, and environmental protection.

Table 2.1
MARINE R&D PROGRAM FRAMEWORK

REGULATION AND SAFETY M100	SHIP PERFORMANCE IN ICE M200	MARINE NAVIGATION & COMMUNICATION SYSTEMS M300	SHIP AUTOMATION AND HUMAN FACTORS M400	TECHNOLOGY ASSESSMENT M500
ARCTIC SHIP REGULATIONS M110	PERFORMANCE PREDICTION IN ICE M210	NAVIGATION IN ICE (Commercial) M310	SHIP AUTOMATION AND CONTROL M410	EMERGING TECHNOLOGIES M510
CONVENTIONAL SHIP REGULATIONS M120	ICEBREAKING SHIP TECHNOLOGY M220	NAVIGATION IN ICE (CCG) M320	MARINE SIMULATION: HUMAN FACTORS M420	WEST COAST TUG AND BARGE M520
SEARCH AND RESCUE M130	FUTURE ICE-CAPABLE SHIPS M230	INSHORE NAVIGATION M330	CREWING: HUMAN FACTORS M430	
MARINE SAFETY M140				
ENVIRONMENTAL PROTECTION M150				

Table 2.2
MARINE PROGRAM
FUNDING REQUIRED FOR PLANNED ACTIVITIES 1991-92 — 1993-94

R&D OBJECTIVES	1990-91 \$000	1991-92 \$000	1992-93 \$000	1993-94 \$000
REGULATION AND SAFETY	739	1 700	1 400	1 400
Arctic Ship Regulations	35	200	200	200
Conventional Ship Regulations	362	145	100	150
Search and Rescue	158	955	500	450
Marine Safety	184	250	300	300
Environmental Protection	0	150	300	300
SHIP PERFORMANCE IN ICE	1 642	700	700	525
Performance Prediction in Ice	915	450	150	100
Icebreaking Ship Technology	520	150	350	350
Future Ice-Capable Ships	207	100	200	75
MARINE NAVIGATION AND COMMUNICATION SYSTEMS	1 185	650	900	1 000
Navigation in Ice (Commercial)	438	500	350	350
Navigation in Ice (CCG)	355	50	250	350
Inshore Navigation	392	100	300	300
SHIP AUTOMATION AND HUMAN FACTORS	196	350	850	825
Ship Automation and Control	196	300	500	500
Marine Simulation: Human Factors	0	0	175	150
Crewing: Human Factors	0	50	175	175
TECHNOLOGY ASSESSMENT	98	80	150	250
Emerging Technologies	98	80	125	225
West Coast Tug and Barge	0	0	25	25
TOTAL	3 860	3 480	4 000	4 000

Arctic Ship Regulations

Research is concentrated on the propulsion systems and structural design of CCG icebreakers, to facilitate the development of safe and efficient designs. The results of this research can be introduced into new and existing ship infrastructures and, where appropriate, into CASPPR.

Current activities focus on improved mathematical models of propulsion trains to predict shaft line and propeller reactions of ships operating in ice, as well as on ship structure behaviour under extreme loads. Research will continue in support of both the ship structure and propulsion regulations.

Conventional Ship Regulations

Conventional ship regulations set minimum ship design standards for lakers and passenger ships operating under Canadian registry in Canadian waters.

Passenger ships (ferries) will be subject to new, proposed IMO standards for residual stability. An evaluation of the existing watertight subdivision design will be completed to determine whether current passenger ships meet the new regulations.

Research will begin on adapting new packaging and inflation system designs to conventional life rafts.

Search and Rescue

The CCG is responsible for the provision of safe and efficient search and rescue services. Improvement in response time through the introduction of new technology can save lives, as well as reduce the costs of this service. The principal R&D effort is directed toward understanding drift patterns, improving detection techniques (through air-droppable marker buoys, among other approaches), and investigating the possibility for direct communication links between search and rescue units and the rescue control centre.

Marine Safety

Research will continue on the development of Arctic survival procedures and equipment requirements and specifications in support of crew survival. Marine traffic regulators are faced with increasingly complex tasks. Designing workstations that will help them perform these tasks will require ergonomic analysis and subsequent prototype development.

Improvement to existing navigation aids and new buoy designs will be delivered to the CCG, in an effort to minimize ice accretion and the expenses incurred in the operation of navigation aids.

Research into methods of improving vessel tracking equipment and the provision of a low cost, radar backhaul to Vessel Traffic Services (VTS) centres will be initiated.

Environmental Protection

This program is a recent research initiative for TDC. As Transport Canada is responsible for preserving the Canadian marine environment, it must minimize the risk of pollution and respond quickly in the event of any incident that threatens the environment. Research efforts will be directed toward investigating technologies that can help detect and track oil spills (surface or submerged) and improve response time to major oil spills. An investigation into ship operations that may pollute the environment will also be initiated. A better understanding of these operations will guide methodologies for safe transportation of ship-borne pollutants. Research into tanker subdivision will be initiated.

2.1.2 Ship Performance In Ice

Research into ship performance in ice is a continuing effort. Hull forms and power plants must be designed to achieve adequate ship operating capability in level ice as well as in ice ridges.

The current program addresses performance prediction in ice, icebreaking ship improvement, and the design of future ice-capable ships.

Performance Prediction in Ice

The principal research efforts are keyed to refining analytical models for predicting ship power requirements for specified level ice performance and ice ridge transiting. Modelling techniques for propeller-ice interaction and ridge-breaking capability will be further explored to provide input on the power levels required to break ice of varying thicknesses and strengths. Methods for correlating model ice resistance with full-scale data will continue to be studied.

Icebreaking Ship Technology

Efficient icebreaking ships are required for the variety of manoeuvres and ice conditions associated with Arctic operations. Safe, efficient ship transportation in the Arctic is of importance, given the sensitive environment.

Research will concentrate on studying the performance of various hull forms, developing propeller protection techniques, investigating hull form stern appendages, and synthesizing design data from various commercial and CCG icebreakers.

Future Ice-Capable Ships

The principal R&D thrust in this program pertains to the development of the next generation of ice-capable cargo ships. Hull form optimization work will continue and a study of tanker risks inherent in Arctic voyages will be initiated.

2.1.3 Marine Navigation and Communication Systems

Research into ship navigation addresses a unique Canadian requirement for finding the best route through an icefield. This technology is of critical importance to marine navigation in the Canadian Arctic, and an efficient ice navigation system is essential for year-round commercial shipping.

The technology for navigating in ports, harbours, and coastal waters is evolving rapidly. The introduction of electronic charts and advances in radio navigation technology and micro-electronics are making sophisticated electronic navigation a practical reality.

The research carried out by TDC addresses three areas of activity: commercial ice navigation; ice navigation technology specific to the Coast Guard; and electronic charts and displays and position-fixing technology for inshore navigation. These technologies have important potential benefits including: reducing the cost of operations in the Arctic; assisting in buoy laying and verification; and providing a low-cost method of precise navigation in the St. Lawrence Seaway that would not require Transport Canada to install a new infrastructure.

Navigation in Ice (Commercial)

Ice navigation technology permits mariners to find the optimum path through an Arctic icefield, thereby reducing transit time, decreasing energy consumption, and improving safety. Considered essential for efficient commercial marine operations in the Arctic environment, this technology is likely to be incorporated into Canadian Arctic pollution prevention regulations.

Canada leads the world in the development of ice navigation technology. Over the past ten years, TDC has supported this development with important contributions from the Energy R&D Program. Canarctic Shipping Co. Ltd., owner of the *M.V. Arctic*, has played an instrumental role in this research, as the world's only commercial ice navigation system is installed on board this vessel.

The Shipboard Integrated Navigation Support System (SINSS) includes satellite links providing a strategic overview of weather and ice conditions, synthetic aperture radar imagery developed in Canada specifically for ice navigation, and specialized ice radars and other technologies (such as sonar) for close detection of ice hazards.

The system detects both hazards in ice-infested open waters and hazards camouflaged in first-year ice or hidden by snow cover. Development of the SINSS technology has been an important aspect of TDC's research program over the past decade. It has resulted in an operational ice navigation system and important spin-offs in ice navigation technology that are being applied on board Coast Guard vessels.

Continued effort will be needed for at least another five years to realize the second generation of this technology. Ice navigation is a specifically Canadian problem and if the technology is not developed in Canada it is unlikely to be available elsewhere. Because mastering this technology is the key to demonstrating that Canada can operate successfully in the Arctic marine environment, ice navigation systems are linked to Canadian sovereignty issues.

The technology also has potential for industrial spin-offs through joint ventures or sales to other countries involved with marine operations in ice-covered Arctic and Antarctic waters.

Navigation in Ice (CCG)

Unlike commercial vessels, Coast Guard icebreakers cannot always operate on a predetermined schedule. Commercial ships generally know their port of departure, route, and scheduled arrival time well in advance. Coast Guard icebreakers, in contrast, can be called out on short notice to assist commercial shipping in virtually any location. CCG therefore requires independent ice reconnaissance capability, based on the SINSS system but augmented by helicopter-borne ice sensors that can provide useful navigation information when satellite or synthetic aperture radar imagery is unavailable.

Inshore Navigation

Electronic charts and navigation displays are revolutionizing ship navigation in coastal waters, confined rivers and lakes, and ports. Much of TDC's R&D effort has been directed toward advancement in the field of navigation computers, electronic charts, and displays that are common to all navigation systems, regardless of whether the basic position input is derived from GPS, Loran-C, or some other position-fixing input such as the RANAV system. Recent activities have focussed on development of advanced electronic displays and the superimposition of radar data on the navigation chart. This work is considered of moderate priority.

2.1.4 Ship Automation and Human Factors

This R&D program addresses ship automation and control, as well as the human factors in marine simulation and crewing. Research into these areas can directly affect ship operating costs by reducing maintenance fees and minimizing crewing requirements, as well as by enhancing human effectiveness. Research efforts will concentrate on developing new computer and communications technologies with a view to integrating ship systems and advancing a preventive ship maintenance program. Improved marine simulation techniques and studies in human factors affecting crewing and shore-based staff will better prepare personnel for adverse operating environments.

Ship Automation and Control

Research into the application of expert system computer technology to ship-board predictive maintenance and the potential for fibre-optic networking on board CCG ships provides the main thrust for this program. Results from this research will further the development of a standard specification for advanced ship control systems. The program funding level is expected to remain stable as initial prototypes are introduced on board ships and operating costs are reduced.

Marine Simulation: Human Factors

TDC has previously been active in the development of a simulator for ice navigation. Task analysis, simulation of navigational conditions, and mathematical models that describe the movement of ships in ice are integral parts of the process. Although no activity is planned for 1991-92, TDC is pursuing the concept development of simulation equipment for marine traffic regulators.

Crewing: Human Factors

Certain crew activities on CCG ships can be extremely demanding from the point of view of strength, agility, and sensory activity. Research will be carried out to ensure that existing standards for physical fitness are adequate and to develop standards for specific tasks related to buoy tending and marine emergencies.

2.1.5 Technology Assessment

The current program assesses emerging technologies that could affect marine transportation in general, as well as West Coast tug and barge research.

Emerging Technologies

New material and fabrication technologies for the marine environment will be investigated. Modest resources to support these activities are anticipated for the planning period.

West Coast Tug and Barge

The main activity under this program will be the trials of an Arctic barge prototype, suitable for sea lift operations.

2.2 Air R&D Program

TDC's air transportation technology program accounts for 24 percent of the total TDC program. Reductions in the level of activity, compared with the 1990-91 program, are due to constraints in the overall TDC 1991-92 budget. Therefore, no new projects are planned for this year, and all resources are dedicated to ongoing research. The three-year projection, however, is based on the assumption that funding is to be restored to the previous level. The program supports Transport Canada's role in air navigation, air traffic control, airport operations, and flight regulations, while stimulating cooperative R&D activities within the air industry. The program areas described in the operational plan reflect the main objectives of TDC's program: security — the continued application of technology to improve air security; safety — technology aimed at reducing the risk of flying; and applications R&D — the adaptation of state-of-the-art products and systems to the needs of Crown procurement.

TDC's research activities stem largely from implementation of the Canadian Airspace Systems Plan, which includes the Radar Modernization Program, the Canadian Automated Air Traffic System project, and the Microwave Landing System Program. TDC supports this work in collaboration with various divisions of Transport Canada Aviation and the Airports Authority Group of Transport Canada. Funding for these activities is supplied mainly from departmental base budgets.

The framework of objectives and sub-objectives for the Air R&D program is illustrated in Table 2.3. The planned R&D activity within each of these objectives and sub-objectives is described below. Table 2.4 shows planned activity levels for 1991-92 and the targeted levels for 1992-93 and 1993-94 for the air program.

2.2.1 Flight Safety

Transport Canada has a direct role in ensuring the safety of the Canadian air transportation system. Research and development in the area of flight safety is closely related to the department's regulatory and certification responsibilities.

The current R&D program addresses accident prevention, accident survivability, accident investigation, and the certification of composites and other new materials, as well as crew training and certification. Research results directly support the development of appropriate regulations or address technology areas where Transport Canada's regulatory involvement is anticipated.

Table 2.3
AIR R&D PROGRAM FRAMEWORK

FLIGHT SAFETY A100	AVIATION SERVICES A200	AIRPORTS A300	ADVANCED CONCEPTS A400	SECURITY A500
ACCIDENT PREVENTION A110	WORKSTATIONS AND HUMAN-MACHINE INTERFACES A210	AIRPORT SECURITY A310	ADVANCED CONCEPTS AND TECHNOLOGIES A410	THREAT DETECTION A510
ACCIDENT SURVIVABILITY A120	AVIATION METEOROLOGY A220	OPERATIONS A320	INFORMATION DISSEMINATION A420	COUNTER- MEASURES A520
ACCIDENT INVESTIGATION A130	NAVIGATION AND COMMUNICATIONS AIDS A230	ENVIRONMENTAL IMPACTS A330	ENERGY CONSERVATION AND ENVIRONMENT A430	
MATERIALS AND STRUCTURES CERTIFICATION A140	DESIGN AIDS A240	RUNWAY DESIGN AND MAINTENANCE A340		
CREW TRAINING AND CERTIFICATION A150	FUTURE AIR NAVIGATION SYSTEMS A250		AIRCRAFT/ AIRPORT ACCESSIBILITY*	

* Carried out under the Accessible Transportation R&D Program

Table 2.4
AIR PROGRAM
FUNDING REQUIRED FOR PLANNED ACTIVITIES 1991-92 — 1993-94

R&D OBJECTIVES	1990-91 \$000	1991-92 \$000	1992-93 \$000	1993-94 \$000
FLIGHT SAFETY	1 213	425	830	925
Accident Prevention	781	180	300	300
Accident Survivability	86	142	400	400
Accident Investigation	56	0	25	25
Materials and Structures Certification	290	103	75	100
Crew Training and Certification	0	0	30	100
AVIATION SERVICES	1 878	1 547	1 470	1 300
Workstations and Human-machine Interfaces	821	387	500	400
Aviation Meteorology	426	274	400	400
Navigation and Communication Aids	196	350	225	200
Design Aids	435	486	295	250
Future Air Navigation Systems	0	50	50	50
AIRPORTS	743	180	490	500
Airport Security	623	0	65	75
Operations	68	135	125	125
Environmental Impacts	52	45	150	150
Runway Design and Maintenance	0	0	150	150
ADVANCED CONCEPTS	369	368	560	625
Advanced Concepts and Technologies	284	10	300	325
Information Dissemination	0	172	60	100
Energy Conservation and Environment	85	186	200	200
SECURITY	0	510	650	650
Threat Detection	0	510	600	600
Countermeasures	0	0	50	50
TOTAL	4 203	3 030	4 000	4 000

The research also tends to focus industry attention on accident prevention and safety practices, thereby providing a moderate-cost alternative to the development and implementation of regulatory controls.

Accident Prevention

This research is directed toward understanding new technologies and operating practices that could significantly reduce aircraft accidents. It leads to the development of safety technology that can be adopted by the industry or, where appropriate, regulated by Transport Canada. Current activities centre upon aircraft deicing with emphasis on the effects of a new "family" of deicing chemicals (i.e. anti-icing fluids) on commuter aircraft. Other work deals with sensors for detecting ice accumulation on aircraft surfaces.

This should continue to be an important activity area, with expenditures remaining at about the current level over the planning period.

Accident Survivability

Accident survivability is another major R&D area with high priority over the planning period. Its funding will remain at the current level or may increase slightly. The principal effort is directed toward improved Emergency Locator Transmitter (ELT) technology.

Current ELTs are the most effective method of determining the location of downed aircraft, thereby reducing search time and greatly improving the possibility of finding survivors. They also significantly lower the cost of search and rescue by Transport Canada and other government departments.

However, the current generation of ELTs has significant shortcomings. First, approximately 90 percent of ELT activations are false alarms, which are costly and time-consuming to rectify and undermine the credibility and effectiveness of the entire system. Even more disturbing, in approximately 65 percent of accidents, the ELT fails to operate.

A new generation of ELTs (TSO C91A standard introduced by the U.S. Federal Aviation Administration) is being evaluated in Canada to determine whether the improvements obtained from this specification are sufficiently important to warrant new regulation. A new approach — a lower-cost, fly-away ELT — is also being examined for possible development in conjunction with the introduction of 406 MHz satellite-based search and rescue beacons. A cooperative development program between TDC, the Communications Research Centre (CRC), and the National Secretariat for Search and Rescue (NSS), will be initiated, dealing with a new generation of 406 MHz beacons.

The greatest number of aircraft accidents occur with small private aircraft and small commercial aircraft flying in remote areas of the country. The crashworthiness of light aircraft structures will be examined to determine design criteria and retrofit arrangements that would be practical to implement in Canada and could mitigate injuries and reduce fatalities (e.g. use of infant restraints).

An evaluation of personal flotation devices used on board Canadian aircraft and of signalling devices used to locate survivors of accidents over water will be initiated.

Accident Investigation

No activities are planned for this period.

Materials and Structures Certification

Transport Canada certifies the airworthiness of aircraft materials and structures, and controls the inspection and testing procedures. With the increasing use of composites and other advanced materials, regulation of aircraft structural integrity and safety, as well as verification of safety characteristics, are becoming increasingly difficult. In many cases there are simply no methods available to test and verify the airworthiness of new materials.

Understanding the safety implications of these materials and developing appropriate verification and inspection technology are long-term activities. This research is considered a high priority by the Aviation Regulation Directorate, and will require continuing effort over the planning period. The work will be carried out in collaboration with Canadian manufacturers.

Crew Training and Certification

Transport Canada issues licences to air crews and is responsible for regulating certification and crew training standards. Research is directed toward assessing human factors in pilot training, and evaluating pilot workload as part of a planned human factors program. This work is considered to have a high priority and will receive a continuing and increasing level of support over the planning period.

2.2.2 Air Navigation Services

Transport Canada's mandate includes providing air navigation services for the national airspace and for some international territory over the Atlantic. These services affect not only the safety of Canadian aviation, but also the capacity and the efficiency

of air operations in these areas. The department is engaged in planning, engineering, implementing, operating, and maintaining these services. R&D is carried out in support of departmental responsibilities and related industry in Canada.

The current R&D program addresses: workstations and human-machine interfaces; aviation meteorology; navigation and communications aids; design aids; and future air navigation systems. The research is primarily aimed at supporting departmental productivity issues as well as industrial positioning of long-term procurement plans.

Workstations and Human-Machine Interfaces

Air traffic controllers, operators, maintenance technicians, design engineers, and managers face growing demands on their time and attention. Their workstations and the human-machine interfaces carry an increasingly important role in the execution of any task involving automation. Efficient automation will require considerable research dealing with the ergonomic aspects of design. Current activities focus on computer-aided learning stations. Attention is also given to intelligent advisory systems for air traffic conflict resolution in both radar and non-radar controlled airspaces and to alternative data entry methods such as voice recognition systems. An additional effort is aimed at ergonomic aspects of weather display on ATC workstation screens.

This program has been identified by Transport Canada Aviation as high priority and will become an important long-term commitment, with expenditures remaining at current levels or decreasing slightly. The R&D work is essential to achieve increased productivity and to maintain or improve safety with increasing air traffic.

Aviation Meteorology

Provision of aviation meteorology information is an important responsibility of the air navigation services, with support from the Atmospheric Environment Service of Environment Canada. The use of advanced systems and algorithms facilitates data collection, identification of hazardous conditions, and provision of timely warnings. Research activities are expected to assess the extent of dangerous meteorological conditions affecting aviation in Canada, and to devise technological solutions. Windshear and microbursts are being studied and work continues on an expert system for airport weather forecasting. R&D in this area is considered high priority and long term; if additional funds can be found, expenditures will increase over the planning period.

Navigation and Communication Aids

These aids are important components of the infrastructure supporting air navigation services in Canada. Long-term plans are published (and updated) in the Canadian Airspace Systems Plan, responding to requirements for improved capacity,

safety, and efficiency. The R&D efforts not only support Transport Canada Aviation and complement its engineering development projects, but also support industry.

The principal effort is directed toward the Microwave Landing System (MLS) project. Existing measurement and engineering instrumentation for MLS applications is limited in variety and performance. As a result, testing and validation of MLS equipment are labour intensive and often require costly airborne procedures. Ground-based testing procedures will require precise tracking of an extendable antenna, which will be moved around an MLS transmitter as part of a commissioning exercise. The tracking concepts for such an antenna will be the subject of additional work.

To allow Canadian aviation to benefit from the powerful capabilities of MLS, TDC will undertake the development of a Level-3 MLS receiver to be used in engineering studies and in the development of MLS-based terminal approach criteria. Other activities related to MLS will concentrate on the feasibility of various back-azimuth configurations aiming at more economical arrangements than the nominal ones.

Design Aids

Design and engineering of facilities and of aviation procedures is a highly skilled, labour-intensive effort. Emerging technologies offer new opportunities to improve the efficiency of design and engineering work undertaken by Transport Canada. The combination of computer tools, advanced graphic systems, and expert systems techniques offers potential for improved design of airways and approach paths. Earlier proof-of-concept work is the basis for the effort to implement a prototype system augmented with a computer-aided learning component to teach the use of the system for designing airways and approach zones. Expenditures on this activity are shared with Transport Canada Aviation and will be substantial over the planning period.

Future Air Navigation Systems

Emerging technologies, particularly airborne computing and satellite terminals, are expected to provide novel means of air navigation. Monitoring of such developments will become a larger area of involvement. Specialized expertise will be developed in this area through technical investigation and engineering services (TIES). Several studies will be initiated in support of the Future Air Navigation System working group of the International Civil Aviation Organization (ICAO) in which Canada is a major contributor.

2.2.3 Airports

The current airport R&D program addresses airport security, operations, environmental impacts, and runway design and maintenance. The results of the research directly support airport security enhancements and capacity and efficiency improvements.

Airport Security

Airport security research is directed toward the special security needs of airports management. This program augments the general security R&D program described in section 2.2.5. Work will include studies of screening station layout design as related to overall airport terminal design.

Operations

The principal effort planned under this sub-objective is directed at terminal airside facility model enhancements and passenger-counting systems to be used in the design of capacity and efficiency improvements. Modelling work is expected to grow in importance and will require increasing resources over the planning period.

Environmental Impacts

Environmental issues are expected to attract growing attention among airport design and management teams. TDC plans to augment its research efforts to deal with construction and operational needs. Halifax International Airport is facing a specific problem: it is built on highly acidic pyritic slate outcrops. A study of sealing alternatives was initiated to prevent damage to water sources in the area. This activity is to be brought to completion over the planning period. Other activities will concentrate on the disposal of deicing fluids, with particular emphasis on biodegradation research. Development of strobe-light bird control techniques and the study of sub-surface contaminants will be initiated. Expenditures are to be maintained and possibly increased for these activities over the planning period.

Runway Design and Maintenance

Runway design, operation, and maintenance represent an important portion of the resources allocated to construction and operation of airports in Canada. Improved methods and procedures offer potential for better efficiency and capacity. The principal effort will be the completion of the study of small aircraft landing patterns in order to examine runway width requirements, particularly in remote airfields. Other research will concentrate on alternative methods of runway deicing to reduce surface damage and negative effects on the environment. Research projects on the use of expert systems for runway maintenance will be initiated.

2.2.4 Advanced Concepts

TDC's R&D program includes exploratory investigations of emerging technologies with potential applications to transportation. These include assessments of generic and enabling technologies, feasibility studies, experimental testing, and sponsorship of consultative workshops and symposia. The current R&D program addresses advanced concepts and technologies, information dissemination, and energy conservation in aviation. Energy conservation responds to the objectives of the federal Energy Research and Development Program.

Advanced Concepts and Technologies

Research into advanced concepts and technologies is largely directed toward exploration of the effects on future airports of the emergence of a civil tilt-rotor (CTR) aircraft. This activity should require moderate resources over the planning period.

Information Dissemination

Consultative workshops on topical issues related to the R&D program will be held, including a workshop on aviation topics as part of the annual Canadian Conference on Electrical and Computer Engineering. Other workshops planned for this period will cover search and rescue, ground deicing, and human factors in aviation. These activities require a modest level of funding over the planning period.

Energy Conservation and Environment

The federal Energy Research and Development Program provides Transport Canada with funding for energy-related R&D pertaining to transportation issues. Activities will focus on investigation of systems and methods that might contribute to energy conservation in aviation. Development of computational aerodynamics methods with a potential for optimizing airframe system performance offers several conservation opportunities. Special composite materials designs offer an opportunity for energy conservation and will be included in the research program. No Transport Canada resources have been allocated to augment the funding for this activity.

2.2.5 Security

Security research is directed toward the development of threat detection and countermeasures.

Threat Detection

Threat identification technologies such as portals, carry-on luggage screening, and baggage checks will be developed. The principal threat is considered to be related to checked baggage; therefore the major effort is directed toward explosives detection. However, current procedures for inspection of passengers and hand baggage are slow, labour intensive, and not fully effective. Advanced technology is being developed to improve the effectiveness and reduce the cost of inspection of all passengers and baggage. Current activities focus on ion mass-spectrometry "sniffing" of explosives, an advisory system for X-ray operators screening on-board luggage, vapour laser preselectors to be used with chemical "sniffers", and material identification by means of acoustic detection. It is anticipated that this area will continue to expand as a high-priority activity over the planning period.

Countermeasures

Development of countermeasures will augment the industry's capability to reduce security risks. The outcome of a study to be initiated on the development of cargo containers with increased resistance to explosion will determine whether a prototype is to be developed.

2.3 Highway R&D Program

The highway system serves as Canada's primary mode of transportation for most goods and people in all but a few specialized markets. For the 1990s and beyond, the system will continue to be a key factor in supporting and promoting interprovincial and international trade and tourism, and in maintaining the high level of personal mobility that Canadians have come to expect. Because no single agency is responsible for all facets of highway transportation, all levels of government and industry must cooperate if progress is to be made in adapting new technologies to highway operations. This is particularly true today as we stand on the threshold of a revolution in highway transportation. In the not-too-distant future, computers, communications, and other electronic technologies will be integrated to generate an "electronic highway" that inseparably links driver, vehicle, and roadway in a system that can provide any combination of traffic and vehicle control, fleet management, navigation, and driver advisory functions.

The framework of objectives and sub-objectives for the highway R&D program is presented in Table 2.5. The structure is unchanged from last year, when significant modifications were incorporated. Essentially, the truck technology project areas were regrouped to distinguish more clearly between projects involving vehicle technology per se, and those aimed primarily at improved safety or more effective management of heavy vehicles within the highway system. Also, to give more prominence to the program developing in this area, exploratory R&D on intelligent vehicle-highway systems was moved to the technology evaluation and program planning project group. One new sub-objective has been added this year, covering innovative transit bus technology. The planned activity under each of the objectives and sub-objectives is described below.

The highway R&D program area stresses cooperative research with the provinces and the private sector to foster a coordinated, cost-effective national approach to highway R&D. TDC acts as a catalyst in trying to have issues addressed by all concerned: highway and trucking associations, motor carriers, manufacturers, and various government jurisdictions. Funding for highway projects comes mainly from two sources — TDC's base budget and the Energy Research and Development Program. The highway R&D program accounts for 18 percent of the total TDC program. In many cases the TDC project covers only part of a broader program being undertaken jointly with other agencies. Thus the total level of effort devoted to some of the R&D areas described in this plan is much greater than that implied by the expenditure levels shown. The planned activity levels for 1991-92 and the targeted levels for 1992-93 and 1993-94 for the highway program are shown in Table 2.6.

Table 2.5
HIGHWAY R&D PROGRAM FRAMEWORK

INFRASTRUCTURE H100	TRUCK TECHNOLOGY H200	BUS TECHNOLOGY H300	TECHNOLOGY EVALUATION AND PROGRAM PLANNING H400
COOPERATIVE NATIONAL PROGRAMS H110	TRANSPORTATION OF DANGEROUS GOODS H210	INTERCITY BUS TECHNOLOGY H310	SYSTEM EFFICIENCY AND PRODUCTIVITY H410
HEAVY VEHICLE COMPLIANCE TECHNOLOGY H120	HEAVY VEHICLE SAFETY H220	TRANSIT BUS TECHNOLOGY H320	TECHNICAL SUPPORT H420
VEHICLE - PAVEMENT INTERACTION H130	HEAVY VEHICLE TECHNOLOGY H230	INTERCITY BUS ACCESSIBILITY*	
	ENERGY CONSERVATION AND SUBSTITUTION H240	MULTIMODAL TRANSIT TECHNOLOGIES**	

* Carried out under the Transportation Accessibility R&D Program

** Carried out under the Multimodal R&D Program

Table 2.6
HIGHWAY PROGRAM
FUNDING REQUIRED FOR PLANNED ACTIVITIES 1991-92 — 1993-94

R&D OBJECTIVES	1990-91 \$000	1991-92 \$000	1992-93 \$000	1993-94 \$000
INFRASTRUCTURE	879	405	600	550
Cooperative National Programs	180	203	250	200
Heavy Vehicle Compliance Technology	699	202	250	250
Vehicle-Pavement Interaction	0	0	100	100
TRUCK TECHNOLOGY	1 193	1 428	1 600	1 600
Transportation of Dangerous Goods	41	0	100	100
Heavy Vehicle Safety	126	465	450	450
Heavy Vehicle Technology	197	221	350	350
Energy Conservation and Substitution	829	742	700	700
BUS TECHNOLOGY	196	128	300	300
Intercity Bus Technology	61	28	150	150
Transit Bus Technology	135	100	150	150
TECHNOLOGY EVALUATION AND PROGRAM PLANNING	113	239	300	350
System Efficiency and Productivity	28	131	200	250
Technical Support	85	108	100	100
TOTAL	2 381	2 200	2 800	2 800

2.3.1 Infrastructure

Because of inadequate spending on infrastructure maintenance and development, the national highway system is deteriorating. Estimates based on current deficiencies have determined that additional expenditures of at least \$1 billion per year over the next ten years are needed to remedy the situation. By undertaking a selective program of research in highway infrastructure, TDC seeks to foster a coordinated national approach that will ensure maximum benefits from R&D in terms of the cost-effectiveness of expenditures on the highway system.

Cooperative National Programs

TDC will continue to participate in the Canadian Strategic Highway Research Program (C-SHRP), which addresses the problems of maintenance and rehabilitation of Canada's highway system, with increased emphasis on technology transfer as the research activities are completed toward the end of the planning period. TDC will encourage cooperative research in all areas of highway transportation by supporting the R&D coordination activities of the Transportation Association of Canada (TAC) and the TAC R&D Council. The latter now provides the primary forum for comment and guidance on the overall direction of TDC's highway R&D program.

Heavy Vehicle Compliance Technology

A major thrust that will continue over the three-year planning period concerns the application of technology to improve the monitoring of compliance with regulatory requirements and to facilitate the management of heavy vehicles within the highway system. Demands for greater productivity in the trucking industry, safer highways, and preservation of the country's infrastructure require better industry control of vehicle loadings, improved understanding of highway use, and better administration of existing laws and regulations.

By participating in the U.S. Heavy Vehicle Electronic License Plate (HELP) program with test sites in British Columbia, TDC will demonstrate the improvements in heavy vehicle management technologies that are possible through the use of automatic vehicle identification (AVI), weigh-in-motion (WIM), and automatic vehicle classification (AVC). The combination of these technologies will permit much better road-use data to be collected with less effort; will allow trucks to by-pass weigh stations if the WIM and AVI indicate that the truck is in compliance with the various regulations; and may permit communication to and from the truck.

Potential follow-on technology projects include the development and demonstration of portable AVI/WIM equipment and the marrying of HELP technology with electronic data interchange to facilitate border crossings at Canada/U.S. points of

entry. TDC is also participating in the planning of a second major system demonstration of heavy vehicle monitoring on U.S. Interstate Highway I-75 and its links in Ontario and Quebec.

Vehicle-Pavement Interaction

A better understanding of the relationship between vehicle suspension dynamic characteristics and pavement wear is a prerequisite to the development of integrated suspension and pavement design criteria, which could lead to significant reductions in overall highway system costs. A cooperative program of Canadian research on the effect of heavy vehicle suspension design on pavement performance is being discussed; however, budget constraints will probably delay the start of work until at least the second year of the planning period.

2.3.2 Truck Technology

Truck technology R&D constitutes the largest element of TDC's highway program and will be maintained at a high level during the course of the three-year planning period, representing approximately 60 percent of total expenditures. TDC's focus on heavy vehicle issues is in response to the increasing role of highway freight transport in Canada's economy and mounting concern about the effects on safety of the growing number of larger and heavier vehicles on the road.

The truck technology work now under way is based on extensive consultation that culminated in the publication in March 1989 of the TDC report *Research and Development Opportunities for Advancing Highway Freight Transport Technologies* (TP 9473E). The program seeks to improve the safety, productivity, and efficiency of trucking and also addresses specific issues such as the transportation of dangerous goods and energy use. The primary mechanism for guiding TDC's program and ensuring effective coordination with other agencies is TAC's Heavy Vehicle Research Coordination Committee.

Transportation of Dangerous Goods

Under the Transportation of Dangerous Goods Act, Transport Canada has a direct responsibility for the transportation of hazardous goods. TDC continues to work closely with the staff of the Transport Dangerous Goods Directorate to identify projects to be undertaken on their behalf. However, because the development of an expert system to interpret dangerous goods regulations has been transferred to the multimodal R&D program, there will be no expenditures in this area under the highway program during 1991-92. Activity will be limited to the planning of a demonstration of wide-area tracking and dispatching using two-way satellite communications, technology which could offer important benefits in the safe transportation of hazardous materials.

Heavy Vehicle Safety

Transportation safety is Transport Canada's number one priority. Concern is growing about the effects on highway safety of the greater numbers and increased size and weight of heavy trucks on the road. The public is particularly concerned that in fatal accidents involving trucks it is the occupant of the other vehicle, usually a passenger car, who is fatally injured. Grouped under this sub-objective are projects that will provide information of most direct interest to Transport Canada's Road Safety and Motor Vehicle Regulation Directorate or Motor Carrier Policy and Programs Branch in the exercise of their regulatory functions. They represent only a part of the safety-related research included in the highway program.

Work to be undertaken during the planning period involves vehicle technology, human factors, and improved methodologies for accident data collection and analysis. The major project is an operational demonstration of an antilock braking system (ABS) on B-train double tankers, a cooperative Canadian project that complements U.S. work by the National Highway Traffic Safety Administration. A supplementary project will test both ABS and traction control systems in the extreme environment of log truck operations. In the area of driver performance, TDC will initiate a field study on truck driver fatigue, and is participating in a U.S. project on the use of simulators in driver training with a view to defining potential areas for Canadian research. Ongoing projects are addressing the urgent requirement for improved methodologies for collecting accident and exposure data and for techniques that can be used to estimate the effects of technological and regulatory change on road safety. TDC initiated a new program of research in this area in 1990-91.

Heavy Vehicle Technology

TDC will continue its major thrust in the area of heavy vehicle design, with particular emphasis on investigation of the effects of vehicle configuration on rollover and dynamic stability. Almost all projects have improved safety as a primary objective, usually combined with a secondary objective of higher productivity or reduced damage to the highway infrastructure. Projects in this area are generally undertaken in collaboration with provinces or industry associations. Topics to be addressed during the three-year planning period will include: liftable axles, logging truck configurations, suspension load equalization, and the development of IBM PC-compatible software to simulate and analyse the dynamics of combination vehicles. The liftable axle and PC software projects are continuing from previous years. The major project to be initiated in 1991-92 is a cooperative program to investigate logging truck stability, covering the performance of existing designs and the potential for improvement.

Energy Conservation and Substitution

The federal Energy Research and Development Program provides funding for projects primarily aimed at reducing the use of petroleum fuel, either directly through improved fuel efficiency or indirectly through the use of alternative fuels. A major project on heavy vehicle fuel consumption to be completed during 1991-92 is the development of a computer simulation model that can optimize fuel efficiency by addressing the effects of the complex relationships between driver, vehicle, road, and environment. New projects proposed include: an information dissemination program on the results of heavy vehicle fuel consumption research to date; a project to develop an advanced design, energy efficient trailer; and a comparative study on energy usage and emissions of truck and rail freight transportation.

Research in the area of fuel use is expected to be increasingly directed at problems of environmental degradation caused by vehicle emissions. Current projects that will continue during at least the first planning year are investigating technologies to reduce the environmental impact of burning diesel and methanol fuels in truck and bus engines. Work will also continue on new materials and testing procedures for vehicle on-board compressed gas fuel cylinders.

2.3.3 Bus Technology

In previous plans, most transit bus research was in the area of engine and transmission technology. Projects were grouped with related truck engine work as being primarily aimed at addressing Energy Research and Development Program objectives. This year a new project area, specifically covering transit bus technology, has been introduced, highlighting public transportation's fundamental role in sustaining urban development.

Intercity Bus Technology

Research on intercity bus transportation, the most economical and energy-efficient intercity passenger mode, has been a major component of TDC's program over the last decade. Some of this work was initiated in response to industry requests for technical assistance from Transport Canada. Other projects stemmed from internal interest in exploring the potential of advanced bus technology as a cost-effective alternative to rail passenger transportation on certain lines, and in pursuing broader federal government objectives through improvements in the bus mode, particularly to its accessibility to elderly and disabled persons. Bus manufacturing is an important Canadian industry and significant economic and regional development spin-off benefits should result from this research.

With a new generation of intercity buses in production or in an advanced state of development, the major initiatives in development of new bus technology are being

brought to a successful conclusion. Funding for intercity bus R&D under the highway program will be very modest during 1991-92, covering at the most some additional display activities with the Motor Coach Industries (MCI) prototype 45-foot coach. The longer intercity bus developed by MCI with TDC support offers significant improvements in passenger comfort, productivity, and accessibility. This is the first coach to incorporate a washroom accessible to passengers in wheelchairs. At present, however, the vehicle exceeds length restrictions in all Canadian provinces. The challenge remains to remove institutional barriers in order for this design to go into production. The sole intercity bus technology project identified for the three-year planning period is the development and demonstration of a prototype multiplexing system, work that is seen as an important building block in the long-term application of intelligent vehicle-highway systems to heavy vehicles. Even though the project would be jointly funded by industry, TDC does not have the financial resources to provide all the government funding needed. Implementation will depend on arranging additional support from other agencies.

The demonstration of twelve Prévost articulated intercity buses on the Montreal-Quebec City route was completed in November 1990. The project, jointly funded by Transport Canada, Transports Québec, and Voyageur Inc., clearly demonstrated the suitability of the new high-capacity design for line-haul service, and reports will provide detailed technical, operational, and marketing information to other potential users.

Major advances in bus accessibility have been achieved through the successful development and commercialization of wheelchair lift technology resulting from earlier TDC prototype installation projects. The most important current initiative is the long-term demonstration of a fully integrated accessible bus service to measure the potential market for such a service and to investigate the operational issues it raises. This project is being undertaken by Canada Coach Lines, on behalf of the Canadian Bus Association, with six accessible coaches providing service on their main corridor route linking Kitchener, Hamilton, and Niagara Falls in Ontario. Inaugurated in October 1989, the demonstration will continue for three years.

Transit Bus Technology

The general configuration and design of standard fixed-route transit buses has remained virtually unchanged for a quarter of a century. New buses currently going into service are unnecessarily heavy and energy inefficient, with high steps to the passenger compartment that make access difficult for the frail elderly or disabled traveller. Although the requirements for urban transit (type of vehicle and type of service) will change significantly as the population ages, the traditional designs continue to be bought with the expectation of a service life of 12 to 20 years. The time is right for a concerted national program to develop and deploy a new generation of

more accessible, energy efficient, and environmentally friendly transit buses. During 1991-92 TDC will initiate a study on the benefits and costs of advanced, low-floor transit buses and will attempt to define potential industry partners and government funding sources for a major development and demonstration program to be undertaken later in the planning period.

2.3.4 Technology Evaluation and Program Planning

Only by taking full advantage of the latest technological advances will the Canadian highway system be able to meet future requirements for capacity and efficiency. Since a large proportion of the development is occurring outside Canada, the identification and integration of foreign technology is essential. Technology transfer will require a planned and structured approach by industry and all levels of government. TDC's first aim is to foster cooperative mechanisms for assessing national needs and international trends in emerging technologies. The long-range goal is to stimulate the development and deployment of advanced systems most appropriate to Canada's transportation requirements and industrial capabilities.

System Efficiency and Productivity

The most dramatic improvements in efficiency and productivity are expected to come from the application of electronics to highway transportation. Electronics, and computer and communications technologies, have important applications in every aspect of traffic management, driver information systems, fleet monitoring, and vehicle control, leading ultimately to the development of the "electronic highway" that will link vehicle, driver, and roadway. TDC's R&D effort in this area is expected to grow significantly over the three-year planning period. Initially effort will be concentrated on identifying Canadian needs in the area of intelligent vehicle-highway systems through exploratory studies and workshops; this will lead to the initiation of technology development or demonstration projects in later years.

Technical Support

To support the planning and implementation of the highway R&D program, standing offer technical investigation and engineering services (TIES) contracts will continue to be used for studying state-of-the-art technologies, for researching and organizing conferences and seminars, and for providing additional technical expertise on specific projects as required.

2.4 Rail R&D Program

The TDC rail program comprises four main elements (see Table 2.7):

- Regulatory Support
- Safety Technology
- Energy and Environmental R&D
- Research and Technology Transfer

In total the rail program represents 8 percent of the TDC R&D program.

The regulatory support element is divided between support for the Transport Dangerous Goods and the Railway Safety Directorates of Transport Canada, which together make up 48 percent of the total rail program and 54 percent of the allocation of TDC Core Rail R&D funds.

The safety technology element supports technological development leading to improvements in railway safety. Carried out on a cost-shared (typically 50:50) basis with the industrial sector, this element currently receives 20 percent of the rail program budget and 30 percent of the Core Rail R&D budget.

The energy and environmental R&D component represents 21 percent of the rail program budget and is funded wholly by the Energy Research and Development Program administered by the Panel on Energy Research and Development.

The research and technology transfer element is totally Core-funded and represents 11 percent of the rail program budget and 17 percent of the Core Rail R&D budget. The research component consists of applied research carried out by or in cooperation with research laboratories or universities. Technology transfer includes such activities as the support of the Railway Research Advisory Board secretariat function and support for conferences, workshops, and seminars. Table 2.8 summarizes the planned activity levels for 1991-92 and the targeted levels for 1992-93 and 1993-94 for the rail program.

2.4.1 Regulatory Support

Transport of Dangerous Goods R&D

A significant part of the railway R&D program will be directed toward providing regulatory support in matters of the carriage of dangerous goods by rail.

Table 2.7
RAIL R&D PROGRAM FRAMEWORK

REGULATORY SUPPORT R100	SAFETY TECHNOLOGY R200	ENERGY AND ENVIRONMENT R300	RESEARCH AND TECHNOLOGY TRANSFER R400
TRANSPORT OF DANGEROUS GOODS R&D R110	ADVANCED TRAIN CONTROL SYSTEMS (ATCS) R210	ENERGY R310	RESEARCH R410
RAILWAY SAFETY R&D R120	SYSTEM SAFETY R220	ENVIRONMENT R320	TECHNOLOGY TRANSFER R420

Table 2.8
RAIL PROGRAM
FUNDING REQUIRED FOR PLANNED ACTIVITIES 1991-92 — 1993-94

R&D OBJECTIVES	1990-91 \$000	1991-92 \$000	1992-93 \$000	1993-94 \$000
REGULATORY SUPPORT	251	577	590	605
Transport of Dangerous Goods R&D	216	353	360	365
Railway Safety R&D	35	224	230	240
SAFETY TECHNOLOGY	565	240	250	250
Advanced Train Control Systems (ATCS)	128	0	50	50
System Safety	437	240	200	200
ENERGY AND ENVIRONMENT	105	266	275	280
Energy	105	224	225	230
Environment	0	42	50	50
RESEARCH AND TECHNOLOGY TRANSFER	66	137	135	150
Research	38	92	85	100
Technology Transfer	28	45	50	50
TOTAL	987	1 220	1 250	1 285

Fire Safety Engineering

Through work on the protection of tanks carrying liquefied gases, the necessary knowledge has been developed at the University of New Brunswick (UNB) and at Queen's University to deal effectively with the behaviour of tanks exposed to external fire. In the past year work continued at Queen's University on the review of the state-of-the-art in pressure relief valves and on the investigation of tank failure modes and projectile hazards. Work started in 1990 on the testing and modelling of the operating characteristics of pressure relief valves will continue in 1991. Further work is under way to develop a dynamic model of pressure relief valves for pressure liquefied gases. The participation of the Transport Dangerous Goods Directorate on the project review committee will provide continuing input to the direction of these investigations.

A Major Hazards Conference held at Queen's University in May 1990 led to an effort to coordinate the work in this area both within Canada and internationally. The Canadian participants are UNB, Queen's University, the National Research Council of Canada National Fire Laboratory, and Transport Canada. Another initiative has been the initiation of further studies, funded by the Transport Dangerous Goods Directorate, designed to understand the Boiling Liquid, Expanding Vapour Explosion (BLEVE) phenomenon. This is expected to lead to further phases under the TDC program, beginning in 1991.

On the international front UNB has maintained its contact with European research efforts through regular meetings with the U.K. Health and Safety Executive and also through a student exchange program with the École des Mines de Saint-Étienne in France. Exchange of data resulting from field trials and exchanges of information on analytical modelling efforts has enhanced Canadian progress in this area. Initiated by past TDC funding, these university activities continue to provide benefits in terms of improved knowledge.

Urban Area Rail Transport of Dangerous Goods

A study was initiated in November 1990 to evaluate the importance of train speed as a factor in the accidental release of dangerous goods shipped by rail. This study had as one of its objectives the development of a plan for the acquisition of data that would enable a correlation to be made between train speed and dangerous goods release. The initial study will be completed in July 1991, following which further work will be considered based on the study recommendations.

Another area of study related to urban area transport of dangerous goods has been the influence of placement of dangerous goods cars in a train, or train marshalling, on the risk of dangerous goods release in the event of a derailment. The initial study has suggested that available data does not permit obvious conclusions to be

drawn and that a fundamental risk analyses approach to this area of study is needed. A start on this work is planned for 1991-92.

The question of urban area rail transport of dangerous goods is expected to remain an important area of activity for TDC throughout the planning period. Improved data bases on railway accidents are expected to provide a better basis for developing appropriate risk assessments in support of Transport Canada's regulatory decisions on dangerous goods transport by rail.

Tank Car Design and Operations

A major activity will be to define and develop concepts for tank cars of the future. The project "Year 2020 Tank Car" will provide a consistent method of identifying and prioritizing problems with the current designs. Sub-projects will then be defined to assist in the solution of such problems. Some specific sub-projects responding to the general objective of "Year 2020 Tank Car" are already under way or in the definition stage and will continue within the three-year planning horizon: the evaluation of new tank car steels, BLEVE research, modelling and field tests of fire effects on tanks, and tests and studies of relief valve performance.

Dangerous goods operations studies are planned for the assessment of loading and unloading practices, evaluation of cold tapping techniques for lading transfer from distressed cars, and review of tank lining inspection methods.

Emergency Response

The first emergency response project carried out by TDC for the Transport Dangerous Goods Directorate was the electronic waybill project to investigate alternatives to the use of hardcopy waybills as a source of information for emergency response teams at railway accidents. End-of-train devices, which are largely replacing the caboose, thus moving tail-end crew to the locomotive cab, caused additional concern, since in certain collision situations hardcopy waybills carried only at the head-end could be destroyed.

Definition of the technical options and legal interpretation of the implications of adoption of electronic data interchange have been completed. The Directorate is studying this information and follow-on work will depend on the outcome of its analysis and subsequent regulatory actions.

A second requirement identified by the Directorate in the emergency response area involves the use of a device to provide, at a safe distance from an accident site, information on the type and quantity of contents of a transport car or container. Radio tag transmitters, receivers, and encoders represent a technology that could be applied to this requirement given appropriate development of system essentials by the stakeholders.

A study of the feasibility of a cold-tapping device for use by emergency response personnel is being developed. This device would permit railway tank cars and other transportation vehicles to be "tapped" and the lading transferred to another container for safe removal from the accident site.

TDC plans to develop links with the Major Industrial Accidents Coordinating Committee (MIACC), which includes all stakeholders likely to be involved in emergency response to transportation accidents, as well as to participate in MIACC working groups.

In discussions held under the auspices of the Risk Management Branch of the Transport Dangerous Goods Directorate with the Canadian Chemical Producers Association (CCPA) concerning the development of a Dangerous Goods Advisor, the chemical industry showed serious interest in the technology used in a prototype system produced in a prior TDC project. Further investigation is planned with or without Transport Canada's participation. It is considered important that agreement be reached within Transport Canada on the appropriate role for the Department. A decision should be reached in 1991. If TDC is to be involved, a project would be initiated late in FY 1991-92.

Railway Safety R&D

Ergonomics

Although violations of operating rules are rare in railway operations, they play a part in about 80 percent of collisions between trains. For this reason ergonomics receives strong emphasis in the railway safety R&D sub-program.

Because of a common interest in defining the factors affecting operating crew performance on railways, TDC and the Transportation Systems Center in Cambridge, Massachusetts, under the auspices of the Memorandum of Understanding between Transport Canada and the U.S. Department of Transportation, are carrying out a critical incident study of rail operation with a view to:

- obtaining a better understanding of the human factors associated with accidents and near-accidents, particularly the role of operator fatigue/loss of alertness in these incidents;
- assessing the implications of outcomes for future research relevant to the rail regulatory program as well as for accident data collection procedures.

The critical incident study initiated in November 1990 will be completed in 1991. Results will be available to the Transportation Systems Center for designing scenarios for detailed simulations using the "RALES" locomotive simulator at the Illinois Institute of Technology Research Institute (IITRI).

A further study involving the use of magnetoencephalographic (MEG) and electroencephalographic (EEG) techniques will provide input to and extend the outcome of the IITRI simulations in terms of the information-processing characteristics of rail operation under conditions of stress and of fatigue due to sleep deficit. The study, initiated in October 1990, will continue through the fall of 1992.

The results of these projects are expected to define the direction of future work in this area more clearly. Continuing consultation with railways and labour unions, the U.S. Department of Transportation and Transportation Systems Center, and the Railway Safety Directorate will ensure that the work remains relevant to the goal of improved safety in the railway system.

Inspection and Non-Destructive Testing

At the request of the Railway Safety Directorate a study has been initiated on the potential of automatic roll-by wheel defect detection systems in reducing wheel failure accidents. This study, to be initiated in March 1991 and completed within the year, will also address data and research information on wheel defects and failures in order to provide a structured definition of wheel defect occurrences. The direction of follow-on work will be determined in consultation with the Railway Safety Directorate at the conclusion of the initial study.

Crossing Safety

The return on investments made by the railways and all levels of government in improving grade crossings and in supporting driver education programs such as Operation Lifesaver is reflected in substantial decreases in accidents over the past several years: a reduction of 32 percent over the period 1982-89.

However, the 1990 level of 360 accidents across Canada is considered far too high to warrant any relaxation of effort. Over the next two to three years further review and categorization of types and causes of accidents are planned with a view to identifying and initiating research that could help to minimize accidents.

Particular areas to be addressed include further studies of driver behaviour and work to determine optimum methods of increasing the night-time level of train conspicuity, particularly at crossings without automatic warning devices.

2.4.2 Safety Technology

Advanced Train Control Systems (ATCS)

The North American effort now under way under the auspices of the Association of American Railroads to develop an Advanced Train Control System (ATCS) is a direct result of exploratory work undertaken by TDC in the mid 1970s and early 1980s. The widespread introduction of ATCS in Canadian railways should improve operating efficiency and contribute to increased safety.

The main initiative for development of this system has shifted to the private sector. Canadian ATCS development is funded principally by the railway and supply industry, with support from the ATCS Program of Industry, Science and Technology Canada (ISTC). TDC is participating with ISTC in monitoring the Canadian ATCS program.

The safety features of ATCS are of particular interest to Transport Canada. ATCS makes it possible to monitor train speed and compliance with movement authorities, and to apply brakes in a hazardous situation. The largest single cause of train collisions is human error, not equipment failure. The ATCS compliance monitoring feature, available with level 30 ATCS or above implementation, addresses this shortcoming of the existing signalling system.

Over the past three years, TDC's efforts have been concentrated on monitoring the ISTC program through an ad hoc interdepartmental committee and on ensuring thereby that the safety objectives of ATCS are effectively addressed. TDC has also implemented activities to ensure that the technology to achieve ATCS safety objectives is available.

Recently completed ATCS-related projects include the development of an application-specific integrated circuit programmable Reed-Solomon encoder and decoder and the first phase of an investigation of an enforced stop algorithm for signal enforcement in centralized traffic control territory on ATCS-equipped trains.

TDC ATCS-related activity over the next three years could include further development of the automatic train braking algorithm and simulation model development to complement the Association of American Railroads/Railway Association of Canada ATCS specification and testing activity. These initiatives come under the general objective of promoting and facilitating applications of ATCS by Canadian railways that will maximize its safety and economic benefits.

System Safety

Train Inspection

In recent years automated inspection of trains by wayside devices has become a universally accepted way of ensuring safe operations. Axle bearings are probably the single most important item of equipment thus inspected.

Since the 1970s the use of roller bearings in railway service has progressively increased, while plain or journal bearings are gradually being phased out. Infrared wayside scanners, proven highly efficient at detecting the incipient failure of journal bearings, are not so effective in the detection of roller bearing defects. Offsetting to some extent the problem of detection however, is the improved reliability of roller bearings in service.

TDC has undertaken with the Canadian National Railways to evaluate an acoustic bearing defect detector currently being offered to the railway industry on a developmental basis. Acoustic bearing defect detectors have been applied successfully in other industries, but their application in railways is considerably more complex. This project should significantly contribute to enhancing railway safety. It is expected to require about a year of wayside monitoring and tracking of bearing performance subsequent to wayside inspections. The results of this work will be shared with industry.

Future work in the train inspection area will be considered on an opportunity basis in collaboration with the railway industry.

Signalling and Communications

TDC, in conjunction with CN Rail, is currently evaluating the use of guided radar in detecting rockslides on railway lines. A trial of the prototype system began in spring 1991 in the Fraser Canyon. When these trials are completed, development of the system will be reviewed with CN Rail and the supplier.

Track and Structures

Increased life and quality of the track and road bed could improve safety and lead to substantial economies. Significant improvement requires continuing development of more durable road beds with improved stability; improved construction methods and materials (ballast, sub-ballast, geotextiles, etc.); more productive track construction; and improved track and roadway maintenance machines and methods. Faster trains with cars of greater axle loads demand continuing research and development in the design of elements such as rail, frogs, fastenings, pads, ties, ballast, bridges, and subgrade to make them safer, as well as more reliable and durable.

Activity over the next three years will include shared-cost investigations of the fracture toughness of rails under cold temperatures and performance of flat wheel detectors. Other areas of interest for which projects may emerge include improving rail welding in the field, redefining criteria for rail removal from main track, developing concrete tie pads, studying steel fatigue in bridge structures, and developing expert systems for planning track rehabilitation and maintenance. These are long-term investigations responding to the general objective of improving rail safety through the application of technology.

2.4.3 Energy and Environment

Energy

Alternative Fuels

The feasibility of implementing a two-stroke cycle single-cylinder medium-speed research engine program will be established during the early part of FY 1991-92. If there is a positive indication and funding is available, work will commence on establishing the required infrastructure to carry out the research work. A full research program will be prepared based on industrial requirements and government priorities. If the program continues as envisaged the required infrastructure should be available for commencement of the research program during FY 1994-95.

An important component of the program will address the question of energy usage and emissions, and the evaluation of alternative fuels is expected to be a major element.

Other research is contemplated using existing facilities to further technological developments on engine components to improve engine efficiency and versatility while reducing emissions. Likely activities will involve combustion research and development of components made with advanced structural materials such as ceramic and ceramic composites.

Coal Transportation

There are no plans for R&D in rail transportation of coal at TDC beyond the end of FY 1992-93, and activities, if any, in FY 1992-93 will be modest, because this R&D lacks the support of the Task 2.1 Committee (Preparation and Transport), for a number of reasons:

- the perceived incremental nature of improvements to unit train technology (unit trains are the basis for efficient movement of many bulk commodities by rail);

- the ability of railways to undertake such improvements without assistance from PERD;
- uncertainty as to whether R&D will result in significant improvement in costs of coal transport.

A number of projects dealing in the technology of heavy-haul rail transport will be finishing in 1991-92, the most significant being the testing of a low-tare aluminum coal car and the completion of commissioning tests of a wheelset testing rig at NRC. Industry is expected to continue to support these developments following completion of TDC's involvement.

An option with possible potential to significantly improve transportation costs is the use of pipelines. Slurry pipelines have been the subject of TDC research in the past but TDC has chosen not to continue these efforts since other organizations are better qualified to manage R&D in this field of technology. Where economic conditions are appropriate for the use of slurry pipelines and the long-term demand for coal can be predicted with some certainty slurry pipelines may provide a viable alternative to rail. However, TDC does not plan to undertake research in this area.

Environment

The Economic Analysis Directorate of Transport Canada's Policy and Coordination Group has funded a study on energy and environmental factors in intercity freight transportation. The final report on this work is now being completed. The study covered all transportation modes and examined the overall energy and environmental posture of each, projected traffic growth, and the aggregate effects of potential major changes in transportation technologies and modal shifts. The orientation of the study was socio-economic. Technical issues and considerations were only examined from an overall perspective.

To orient Transport Canada actions on energy and the environment, including the development of R&D initiatives and formulation of policies and strategies, the technical status and potential of each transport sector, as well as the associated economics and operational impacts of individual technologies, must be understood. This is especially true in overland freight transportation. The rail program will cover part of the cost of this broad-based study, which will develop strategies for reducing the energy and environmental impacts of overland freight transportation and propose potential R&D initiatives to support reductions in energy use and emissions.

2.4.4 Research and Technology Transfer

Research

Non-Destructive Testing

Over the past year efforts have been concentrated on investigating the problem of both thermal and residual stress in rail and the contribution of these two stress factors to rail failure.

Projects completed during FY 1990-91 included preliminary assessments of ultrasonic and neutron diffraction techniques to measure residual stress in rail. It is planned to devise a program of destructive testing to complement the work to date during the coming year. Early in the period further efforts will be made to determine the most promising technologies for measuring internal stresses induced in rail during the manufacturing and heat treatment processes, with the objective of developing a portable instrument to measure internal stress. A project is planned for the second part of the three-year period.

A shared cost project to investigate the feasibility of determining thermal stress levels of in-situ rail by the use of acoustic/vibration measurement techniques will be initiated during the first year of the period.

Investigations of the possibility of improving current methods of in-situ rail inspection will be undertaken to establish whether there is sufficient justification for TDC to support and/or promote the development of such systems in Canada.

All these projects respond to the general objective of exploiting non-destructive technology in improving inspection methods to determine incipient failure conditions in both track and rolling stock.

Rolling Contact Mechanics

The National Research Council Canada (NRC) Wheel/Rail System Test Facility will be commissioned near the beginning of FY 1991-92 for selected tests. During the first year the system will undergo continuous modifications and upgrading to resolve problems and deficiencies in the current configuration. A flywheel system will be added to provide the necessary inertial loading to simulate the car loading for braking tests. The facility will be used for research on wheel-rail interaction dynamics including creepage and rail corrugation, and for tests required by the railway sector, such as the bearing tests soon to be implemented. Other tests will be carried out on the braking system as well as wear tests on wheels under simulated high axle load conditions.

Other research using the NRC Curved Track Simulator to assess wheelset dynamics is planned.

Materials Technology

The current work in materials technology entails the use of thermally-sprayed metallic and ceramic coatings to cylinder liners for locomotive diesel engines. The performance of thermally-sprayed coupons is now being tested at the University of Manitoba. The project promises to improve wear performance of cylinder liners, as well as to improve environmental conditions of production compared with those of existing chrome plating, which involves the use of hazardous chemicals.

If promising coatings are identified through the coupon tests, subsequent phases will involve endurance tests in engine test cells prior to introduction into operational locomotive engines.

Technology Transfer

Technology transfer includes the ongoing Railway Research Advisory Board (RRAB) activities which provide for the coordination of TDC's program with those of the industrial sector (the Railway Association of Canada, the Association of American Railroads and the Canadian Railway and Transit Manufacturers Association), NRC, and Canadian universities.

RRAB has been exploring the subject of R&D workshops, and bearing health monitoring and ergonomics have been suggested for consideration.

2.5 Multimodal R&D Program

Exploratory R&D activities in emerging technologies and enabling disciplines that have potential benefits applicable to more than one mode of transportation are grouped under multimodal R&D, which is largely funded out of R&D Core Funds. This major program area accounts for about 7 percent of the total TDC program and includes research in micro-electronics, artificial intelligence-expert systems, advanced industrial materials, and ergonomics.

In 1989 a Visiting Experts Program was initiated at TDC to stimulate innovation within Transport Canada. This program, along with seminars and workshops on advanced technologies, technology monitoring, energy R&D, new conventional transportation systems, and urban transportation, is included in the multimodal area.

Prompted by the safety implications of mismatches in the human-machine interface, emphasis on human factors has increased for the planning period. Human factors projects are of interest to both the U.S. and Canada and are defined in the Canada/U.S. Memorandum of Understanding relating to transportation.

Environmental concerns are becoming increasingly important. TDC will respond to the priorities outlined in the government's Green Plan by addressing, in the multimodal R&D program area, environmental issues relating to transportation.

The framework of objectives and sub-objectives for the multimodal R&D program is presented in Table 2.9. The planned R&D activity within each of these objectives and sub-objectives is described below. Table 2.10 shows the planned activity levels for 1991-92 and the targeted levels for 1992-93 and 1993-94 for the multimodal program, assuming that the R&D Core funds are not severely reduced.

2.5.1 Technology Transfer

Technology transfer activities are intended to stimulate innovation in the transportation sector in general, and within Transport Canada's operations in particular. This program thrust focusses private sector expertise, emerging technologies, and enabling disciplines on improving the safety and efficiency of the Canadian transportation system. Technology areas addressed here have applications to more than one mode of transport.

Visiting Experts Program

In accordance with overall government policy, Transport Canada is downsizing its operation and reducing its staff. Turnover within the department is relatively low, making it difficult to hire new staff with fresh ideas and the state-of-the-art knowledge

essential for technical innovation. The challenge of innovation in this environment is being met through the Visiting Experts Program, which enables outside experts to work at TDC on assignments lasting from two to six months.

Visiting experts aid TDC to advance its knowledge and expertise in newly emerging technologies and generate innovative concepts and ideas for Transport Canada's R&D program. To be eligible, candidates must be recognized experts who meet specific standards with respect to education, experience, and research interest.

Visiting experts have no project responsibility, but are assigned to address particular predetermined technology issues. They are required to prepare a paper for publication and to conduct a seminar on the chosen subject. They may also make recommendations to Transport Canada regarding further research in that area.

The program has been implemented as a three-year trial from April 1989 to March 1992. Five visiting experts were at TDC in 1989-90 and one was engaged in 1990-91. Plans call for four to five experts to visit TDC annually, but budget constraints dictate that only one can be accommodated in 1991-92. It is hoped that this program will be restored to its intended level in the subsequent two years. Visiting experts in the following areas are of most interest to TDC: non-destructive testing technologies; human factors, including ergonomics, in transportation; advanced air traffic control technology; satellite communication and navigation; and voice recognition and voice synthesis.

Technical Seminars and Studies

Technical seminars and workshops are another effective means to stimulate and guide technical innovation. TDC intends to increase its activity under this sub-objective over the planning period. In 1991-92 TDC will participate in a number of conferences, and in 1992-93 it will organize an ergonomic seminar on pilot/aircraft systems.

2.5.2 Technology Monitoring

Technology monitoring is undertaken to maintain a basis of knowledge in areas that are not currently a prime thrust of TDC's R&D program, since they could have an effect on Transport Canada in the future. Furthermore, the department is frequently required to respond to requests from the public and from pressure groups advocating the implementation of new technology systems in Canada. Without a technology monitoring program adequate response is impossible. In return for modest efforts on TDC's part to keep abreast of technological change, Transport Canada frequently benefits from information exchange, obtaining data on major programs undertaken with other countries.

Table 2.9
MULTIMODAL R&D PROGRAM FRAMEWORK

TECHNOLOGY TRANSFER I100	TECHNOLOGY MONITORING I200	EMERGING TECHNOLOGIES I300
VISITING EXPERTS PROGRAM I110	TRANSIT AND TRAFFIC TECHNOLOGIES I210	SATELLITE LOCATION AND NAVIGATION I310
TECHNICAL SEMINARS AND STUDIES I120	NON- CONVENTIONAL TRANSPORTATION SYSTEMS I220	MONOLITHIC MICROWAVE INTEGRATED CIRCUITS I320
	ENVIRONMENTAL R&D SUPPORT I230	SPEECH RECOGNITION AND SYNTHESIS I330
	HUMAN FACTORS I240	OTHER NEW TECHNOLOGIES I340

Table 2.10
MULTIMODAL PROGRAM
FUNDING REQUIRED FOR PLANNED ACTIVITIES 1991-92 — 1993-94

R&D OBJECTIVES	1990-91 \$000	1991-92 \$000	1992-93 \$000	1993-94 \$000
TECHNOLOGY TRANSFER	94	48	149	200
Visiting Experts Program	74	40	135	150
Technical Seminars and Studies	20	8	14	50
TECHNOLOGY MONITORING	469	461	518	530
Transit and Traffic Technologies	216	120	39	40
Non-conventional Transportation Systems	162	143	144	140
Environmental R&D Support	73	100	198	200
Human Factors	18	98	137	150
EMERGING TECHNOLOGIES	467	341	534	570
Satellite Location and Navigation	0	10	14	20
Monolithic Microwave Integrated Circuits	18	0	256	200
Speech Recognition and Synthesis	158	50	8	100
Other New Technologies	291	281	256	250
TOTAL	1 030	850	1 201	1 300

Transit and Traffic Technologies

Public transit is vitally important to the majority of Canadians living in urban areas. TDC, in response to ministerial direction, engages in cooperative urban transportation R&D through the Canadian Urban Transit Association (CUTA). TDC has entered into a three-year agreement with CUTA to conduct six projects under the National Strategic Urban Transit R&D Program which expires in 1991. Initial results are favourable and this work could provide a model for future cooperative efforts in this field.

Non-Conventional Transportation Systems

Non-conventional technology may introduce major changes to the transportation system. The scope, impact, and potential benefits of such technology are difficult to evaluate, because it has not received widespread application elsewhere in the world. At most, small-scale systems are in operation; often, work is only at the experimental prototype stage. TDC endeavours to maintain a basic understanding of new technologies considered to have a potential impact on Canada. The level of development required to bring the technology to the operational stage is generally high and exceeds the resources available to TDC. The strategy is to maintain a low level of activity and gain the necessary knowledge through an international exchange of information. Areas of interest include Maglev, advanced LIM control systems, and superconductivity, especially since the Royal Commission on Passenger Transport has renewed interest in high speed rail systems for the Quebec-Windsor Corridor.

Environmental R&D Support

Increasing concern over environmental issues has led to the development of a federal Green Plan, as well as a Transport Canada strategy for environmental R&D. In response to these initiatives, TDC has formulated the following specific thrusts for program planning:

- Emissions from motor vehicles and other transportation sources/fuels.
- Marine spills of toxic and hazardous substances.
- Rail and highway spills of toxic and hazardous substances.
- Environmental impacts of transportation facilities construction and operation.
- Limiting greenhouse gases by improving the energy efficiency of transportation systems.
- Alternative energy sources and advanced energy systems.

- Improved vessel traffic services, shipborne navigation capabilities, and hull form integrity.
- Emergency response methodologies including contingency planning and risk analysis.
- Emergency response systems and technologies including communications systems and decision aids, spill detection monitoring, and compliance enforcement technologies.
- Improved containment and handling of dangerous goods in transit.

TDC's strategy for managing environment-related R&D in 1991-92 is to contract projects through one or more standing-offer contracts with large consulting firms having a range of expertise. This will enable TDC to respond in a timely fashion, despite a shortage of staff with appropriate expertise, to departmental requirements. It will also provide a focus for R&D that often results in immensely valuable technology transfer between transport modes, until the Green Plan Programs begin to take shape. Between 1992 and 1994 TDC intends to tap into resources made available under the Green Plan, after it has been formalized, to mount a significant R&D program in this area.

Human Factors

Human factors are known to account for 70 percent of transportation accidents. With the increased emphasis on safety and productivity, human factors are a priority in the current planning period. TDC is specifically addressing human factors in the design of transportation systems and equipment to optimize the safety, productivity, and capacity of the hardware and the performance of the user. Examples include work on a new air traffic control workstation, driver and rail operator fatigue studies, and magnetoencephalographic studies.

Because of the present staff shortage of ergonomists, TDC will also maintain a consulting capability through contract technical investigation and engineering services that can respond to new or varied ergonomic R&D requirements.

2.5.3 Emerging Technologies

A major thrust of the new R&D policy is toward increased long-term exploratory R&D. Activities are aimed at the development of generic technologies with broad application to more than one mode of transport. The key technologies being addressed include micro-electronics, advanced industrial materials, lasers, and opto-electronics, as well as ergonomics studies to better understand the human-machine interface. Artificial intelligence and expert systems previously explored in this program area are now being developed under specific modal program areas.

Activities under this objective are long range, with the basic technology development not expected to reach operational deployment for five years, or possibly longer. This is a high-priority area, with funding expected to remain relatively high over the planning period.

Satellite Location and Navigation

Satellite systems for location and navigation are expected to have a major impact on the transportation system. Development of satellite location and navigation technologies is a high priority, with emphasis on COSPAS/SARSAT, used in search and rescue efforts. An in-depth assessment of navigation technologies applicable to all transportation modes is planned. The assessment will lead to recommendations for specific R&D in this rapidly emerging area of technology.

Monolithic Microwave Integrated Circuits

A major effort is under way to develop the basic technology for design and production of monolithic microwave integrated circuits (MMIC). This technology offers the potential for reduced size, significantly lower power consumption, and, eventually, lower cost compared with conventional microwave technology. Integrated circuits operating below microwave frequencies have replaced discrete component electronic construction, and MMIC technology offers this possibility at microwave frequencies. Phase 1 of the work has been carried out in conjunction with Communications Canada. The first application is expected to be in future generations of a microwave landing system, with eventual use for antenna steering in all modes of transport and in replacement of conventional microwave components. However, due to budget constraints, this project is on hold for 1991-92. Pending restoration of funding, it will be continued in subsequent years.

Speech Recognition and Synthesis

Speech synthesis is beginning to find application in transportation, and speech recognition is under development worldwide for a multitude of applications. Because of its wide-reaching potential benefits for transportation, TDC has launched a special development effort on this technology. A speech synthesis system, developed to provide travel information, is being strengthened through R&D support of transportation applications in a number of areas, including transcribed weather forecasts issued by Transport Canada.

Speech recognition has potential for development and application in a number of specialized areas within Transport Canada, utilizing much of the technology becoming available. However, considerably more R&D will be required before it can be used in operational service. The potential benefits are such that this development effort is considered a high priority.

Work on both speech synthesis and speech recognition is being carried out with co-funding from industry, which also recognizes their benefits. ITIS, an integrated transportation information system originally demonstrated at Expo 86, is now in full-scale demonstration in Victoria, B.C. The research is expected to continue at a moderately high level throughout the planning period if new funding can be found.

Other New Technologies

In addition to the major exploratory R&D projects already described, a number of other development efforts are under way at a somewhat lower level. The intention is to target the most promising new technologies, carry out some exploratory work, and, where warranted, develop the technologies further. In this high-risk area some preliminary activity must be undertaken to fully understand the potential costs, time frames, and benefits involved in development. Current efforts vary from magnetoencephalography through advanced battery technology to neural network applications for transportation.

2.6 Transportation Accessibility R&D Program

Over the past ten years, TDC's Transportation Accessibility Program has been recognized internationally as the world's best and has brought a number of honours and awards to the organization. In 1988 TDC received the Access to the Skies Innovator Award from the Paralyzed Veterans of America for pioneering in this field.

Accessibility of transportation is guaranteed by the Canadian Charter of Rights and Freedoms. In keeping with a 1984 federal policy on transportation of disabled persons calling for development of accessibility standards for all modes of transportation under federal jurisdiction, the department set up the Transportation of Disabled Persons Implementation Committee (TDPIC). In March 1991 this was reconstituted as the Advisory Committee on Accessible Transportation (ACAT), with a mandate to provide a forum to review, recommend, and advise the Minister of Transport on consumer and industry perspectives and concerns regarding programs, policies, and issues relevant to persons with disabilities and senior citizens. This committee places considerable emphasis on applying technology to resolve transportation problems encountered by elderly and disabled travellers. The committee has a broad consumer and industry membership with government participants as observers.

TDC's accessible transportation R&D, which usually accounts for about 7 percent of the total TDC program, responds to the priorities established by the senior management of the department in the light of ACAT recommendations and advice.

For 1991-92, financial constraints have led to curtailment of the Transportation of the Disabled Persons Program, which traditionally has supplied about 75 percent of the funds for TDC projects. A lower level of TDPP funding in future years is to be expected. As a result new projects can be initiated in 1991-92 only if R&D Core funds are reallocated from competing priorities, or new funds are found from other sources, such as the proposed five-year strategy by the federal government to remove barriers faced by disabled Canadians, as referred to in the May 1991 Speech from the Throne.

Under such uncertainty, the framework of objectives and sub-objectives for this reduced R&D program as presented in Table 2.11 can only be viewed as tentative.

The total funds allocated to this program area for 1991-92 amount to \$850 000 from all sources. It is difficult to predict the level of project work over the three-year planning period, but it is assumed that a similar level of funding from the R&D Core, with possible relief from "Other Sources" (see Table 2.12), will maintain the program at a reasonable level.

If this program continues, TDC intends to complete projects under System Accessibility while steadily increasing work in the Communication and Orientation area, especially for the sensory and cognitively impaired, as well as in the area of Safety. Efforts on modes outside direct federal jurisdiction and on development of new technologies would only materialize if new funds from the government's enhanced program for the disabled were made available to TDC.

2.6.1 System Accessibility

For more than 17 years TDC has been carrying out R&D projects to foster the development of equipment, systems, and procedures designed to make the entire travel continuum accessible from trip origin, through terminals and transfer points, to the final destination.

Aircraft and Airports

In North America, the legislative process and technical developments have ensured that an accessible air transportation system for larger aircraft is largely in place. However, deregulation has changed the airline infrastructure, and feeder service, resulting in hub and spoke operations, is now commonplace. Consequently, accessibility of smaller feeder and commuter aircraft has become of prime concern.

TDC's R&D on accessibility of air transportation is grouped into three major areas:

- terminal to aircraft transfer;
- storage of mobility aids; and
- terminal facilities.

Work on terminal to aircraft transfer highlights advances in R&D related to the boarding of disabled passengers onto both large and small aircraft. An enclosed pallet to be used with a forklift for boarding large aircraft is being demonstrated. An elongated pallet may be developed to accommodate travellers on stretchers. Since industry has stated that in the near future all large aircraft will be boarded by loading bridges, the pallet solution is considered to be an interim solution to boarding problems encountered in the transitional phase of bridge deployment.

To overcome the level change problems of small aircraft, concepts for a low-level boarding bridge and an integrated platform lift and stairway boarding system were considered. Before TDC embarked on the design and the development of a promising alternative, it was discovered that a manufacturer was well advanced in the design of a level change device. TDC conducted an ergonomic review of the device and determined that it shows great promise. TDC's role will be to evaluate its effectiveness in operation.

Table 2.11
TRANSPORTATION ACCESSIBILITY R&D PROGRAM FRAMEWORK

SYSTEM ACCESSIBILITY E100	SAFETY E200	COMMUNICATION AND ORIENTATION E300	TECHNOLOGY DEVELOPMENT AND TRANSFER E400
AIRCRAFT AND AIRPORTS E110	WHEELCHAIR PASSENGERS E210	SIGHT AND HEARING IMPAIRED TRAVELLERS E310	ENABLING TECHNOLOGIES AND DISCIPLINES E410
MARINE VESSELS E120	ELDERLY AND DISABLED DRIVERS AND PEDESTRIANS E220	COGNITIVELY IMPAIRED TRAVELLERS E320	TECHNOLOGY SUPPORT AND INFORMATION TRANSFER E420
INTERCITY BUS E130			
ACCESS AND EGRESS MODES E140			

Table 2.12
TRANSPORTATION ACCESSIBILITY PROGRAM
FUNDING REQUIRED FOR PLANNED ACTIVITIES 1991-92 — 1993-94

R&D OBJECTIVES	1990-91 \$000	1991-92 \$000	1992-93 \$000	1993-94 \$000
SYSTEM ACCESSIBILITY	617	339	135	210
Aircraft and Airports	16	43	66	70
Marine Vessels	45	190	0	0
Intercity Bus	203	50	41	35
Access and Egress Modes	353	56	28	105
SAFETY	288	275	325	210
Wheelchair Passengers	90	14	45	70
Elderly & Disabled Drivers and Pedestrians	198	261	280	140
COMMUNICATION AND ORIENTATION	209	179	315	280
Sight and Hearing Impaired Travellers	209	179	280	175
Cognitively Impaired Travellers	0	0	35	105
TECHNOLOGY DEVELOPMENT AND TRANSFER	152	67	254	245
Enabling Technologies and Disciplines	0	0	70	175
Technology Support and Information Transfer	152	67	184	70
TOTAL	1 266	860	1 029	945

TDC has found technical solutions to the carriage and storage of mobility aids. They focus on protective containers for wheelchairs and the in-cabin storage of manual wheelchairs. Implementation of these solutions now lies in the hands of the airlines, rental car agencies, and airport operators.

The key issue of transfer chairs, both inside the terminal and on board, especially on small aircraft, remains an acute problem to wheelchair users. Most wheelchair users wish to keep to their own customized mobility aids and to minimize transfer to avoid physical discomfort. The diversity of wheelchairs, aircraft configurations, aisle widths, and washroom designs demands that a technical solution be developed. If funds are found, the next three years will see projects launched in this area, since it is one of Transport Canada's high-priority areas.

Accessibility to airport services and facilities must respond not only to the needs of travellers with motor disabilities, but also to the needs of those with hearing, sight, or speech impairments. This work is carried out under the Communication and Orientation area.

The 1987 National Transportation Act was passed to provide disabled persons with equal access to transportation services. New regulations and equipment standards are being prepared by the National Transportation Agency to make this possible.

The implementation of these standards and regulations calls for further R&D initiatives to provide creative and cost-effective technical solutions to unresolved accessibility issues. In the immediate future, concerns are related to the effective deployment of the technical solutions already developed. To this end, a video describing the existing technology, its benefits, and implementation methodologies is being produced. Solutions to air travel accessibility have been developed under challenging circumstances: an industry still in evolution because of deregulation; growing air traffic and overloaded airways; crowded terminals; and an ever-increasing concern for passenger safety, both on the ground and in the air. Deployment of these solutions faces the same challenging environment.

Marine Vessels

In 1990-91 TDC installed elevators to transport passengers from the car-deck to the mezzanine deck and from the mezzanine to the promenade deck of the *M.V. Prince Edward*, a ferry operating in the East. Over the planning period, TDC will assist the Marine Group to assess this installation and to develop technical recommendations for making ferries accessible.

Intercity Bus

Long-distance travel by intercity bus is still one of the most affordable means of transportation for many Canadians. In rendering intercity bus travel accessible, the following components need to be addressed:

- vertical access from road level to bus floor level;
- access and egress to and from seat;
- passenger securement and wheelchair restraint;
- access to and use of washroom; and
- information and communication.

The TDC intercity bus accessibility program has led to major advances through the development of wheelchair lift technology using internal elevators. The first prototype lift-equipped bus has now completed five years of service in Newfoundland and a structural verification to gather life-cycle data on the design has just been completed. Motor Coach Industries' current production version of lift-equipped buses is now in service in the second year of a three-year demonstration of a fully integrated accessible intercity bus service with Canada Coach Lines in the Hamilton-Niagara corridor (see section 2.3.3).

A 45-foot bus has been developed with accessible features that have a minimal effect on the capacity of the bus when they are not in use. This work is further described in section 2.3.3. An ergonomic assessment of intercity bus washrooms has been completed. The plan to demonstrate this nationally has been postponed until next year, pending availability of funds.

The development of station-based boarding systems remains a challenge. R&D results thus far indicate that station-based devices for buses not equipped with lifts are awkward and difficult to operate. Despite several attempts, including a design competition, to develop a device, no promising solution has been found. During the planning period, the search for a viable station-based lift will be in abeyance because of uncertainty of funding.

Access and Egress Modes

While access and egress modes do not fall under federal jurisdiction, it is futile to make line-haul modes accessible if elderly and disabled passengers cannot get to the terminals. TDC's efforts in this area are normally undertaken jointly with provincial, municipal, and urban transit authorities in order to improve accessibility of collective modes (e.g. fixed route buses, paratransit operations), to demonstrate the feasibility of various types of accessible vehicles, and, finally, to examine technology to help disabled drivers.

With provincial and operator co-sponsorship, major efforts in developing several computerized dispatching systems for paratransit operations in Vancouver and Edmonton have been successfully completed. Minor enhancements to improve the Vancouver system have recently been completed. No further work is planned in this area but the need to develop a mechanism for technology transfer remains.

A demonstration of HandyLine, an adaptation of telephone communications that permits automatic reservation and confirmation of requests for paratransit services, is under way in Vancouver. This system promises to improve service efficiency by automating routine inquiries and services and by handling reminder calls to clients, thus reducing "no shows" and boarding delays. This project will be completed at the end of 1991.

Over the planning period, the principal focus will be accessible taxi demonstration projects. These projects include developing and selecting suitable vehicles, designing the demonstration service, and evaluating the results. TDC has participated in trials of several commercially available vehicles for taxi use. The accessible taxi demonstration in Ottawa, now completed, underlined the need for the development of a suitable vehicle. Efforts directed toward a redesign of the GSM taxi to meet the requirements of elderly and disabled users resulted in one GSM Parataxi now in demonstration service in Montreal. The Quebec Accessible Taxi Demonstration funded by ERDA is now in full service and undergoing evaluation.

Investigations on technical aids to assist elderly and disabled drivers will complement R&D work in public transportation. During the planning period, technology such as self-loading devices, passenger restraints, wheelchair securement systems, and other means to increase the personal mobility and the independence of disabled drivers need to be investigated. Micro-electronic technology, such as in-vehicle guidance, cellular telephone communication, and emergency location systems, provides great promise in helping disabled persons to safely achieve mobility and independence. Due to the curtailment of the TDPP program, this can only be studied if new funding sources are found.

2.6.2 Safety

Current activity to improve the safety of elderly and disabled travellers has two components: wheelchair securement and passenger restraint systems for wheelchair users; and safety for elderly drivers and pedestrians. Over the planning period, increased emphasis will be placed on these areas if possible.

Wheelchair Passengers

TDC has worked on the development of securement systems for various types of vehicles, and has successfully developed and tested securement units on trains and multimodal wheelchair securement units for vans and minibuses.

The most critical issue affecting the safety of elderly and disabled travellers is the lack of national standards for vehicles, wheelchairs, and mobility aids used in transportation. TDC is supporting work aimed at developing or revising Canadian Standards Association (CSA) standards in the following areas:

- revision of vehicle standard D 409;
- definition of what constitutes a transportable wheelchair; and
- mobility aid securement and passenger restraint systems.

A joint federal-provincial effort with CSA and CUTA has been launched to encourage provinces to refer to the CSA standards in provincial regulations. This project is expected to end in 1992-93. Work on standards for adaptive hand controls, requested by the Airports Group, is the next priority.

Elderly and Disabled Drivers and Pedestrians

A review of Canadian accident statistics reveals that elderly drivers, at least up to the age of 75, are not responsible for a disproportionate number of traffic accidents. However, when amount of exposure is considered, the accident rate of elderly drivers increases. The elderly have the highest pedestrian accident rate of any segment of the Canadian population. On a per capita basis, the fatality rate for elderly pedestrians is 2.5 to 3 times greater than the rate for the total population.

Canada's population continues to age. By 2025, about 19 percent of Canadians are expected to be aged 65 and over, compared with 8 percent in 1950. The majority will probably wish to continue driving as long as possible.

Substantial research and development work has been undertaken to improve the safety of persons with disabilities, many of whom are elderly, but not much has been done for the elderly as a group. TDC is working in conjunction with the Office of the Minister of State for Seniors to define the problems and needs of elderly pedestrians and drivers. The most notable work in this area is the development of a low-cost, high-fidelity driving simulator. Driving can play a significant role in the continued independence of people whose mobility has been impaired by accident, age, or disease. The simulator will be an important tool in evaluating the capability of elderly and disabled persons to drive an automobile. This work is on the leading edge of PC-based simulator technology and has potential for application in other modes.

2.6.3 Communication and Orientation

Canadians with disabilities cannot be treated as a homogeneous group. Two-thirds of the disabled population aged 15 and older report having more than one type of disability. The prevalence of multiple disabilities increases with age. While most of TDC's work relates to the physically disabled, more than 40 percent of the disabled population is made up of people with sight, hearing, or speech impairments.

Sight and Hearing Impaired Travellers

The solutions to the travel problems of this group lie less in new R&D activities than in implementation of well-established technology. Existing technology can help with communication and orientation in vehicles and terminals and in making travel arrangements. TDC hopes to allocate slightly increased resources to the area of signage and tactile aids for persons with perceptual and sensory impairments. Evaluation of infrared loop systems for the hearing impaired traveller has been completed.

Cognitively Impaired Travellers

The transportation problems of cognitively impaired travellers remain difficult to define. More work will be carried out to eliminate communication and orientation barriers via modern micro-electronic and informatics technology. The merit of training and education of both potential travellers and travel service providers should be investigated.

2.6.4 Technology Development and Transfer

Enabling Technologies and Disciplines

TDC is committed to fostering the application of new technologies to the development and improvement of transportation accessibility. For example, the application of a knowledge-based CAD system to the development and evaluation of ergonomically suitable transportation technologies for elderly and disabled persons would assist designers and planners of such technologies. At present, an appreciation of human factors is conspicuously absent in many new designs. Over the planning period, a knowledge-based CAD system should be developed and evaluated. This innovative use of artificial intelligence and CAD concepts offers guidance to the designer by a computerized "consultant" in human factors. This "exploratory research" will be pursued only if other sources of funds can be found.

Technology Support and Information Transfer

The transfer of developed technology to the user and the transportation provider is the main challenge of this program area for the immediate future. Due to funding cuts, the Driver Educator Workshop must be postponed from 1991-92 to 1992-93. A taxi driver training program will be completed in 1991-92.

R&D results will be disseminated through workshops, conferences, published reports, and exhibits. Since elderly and disabled groups are diverse and fragmented, effective communication will ensure that key results are being applied and adopted. A major project to develop a planning handbook describing the results of 17 years of R&D for the use of transportation planners has been postponed pending funding availability.

In conclusion, due to the uncertainty of R&D funding at the time of writing, the above plans represent the direction of a scaled-down program if it is Transport Canada's intention to continue working in this area. However, if new funding sources are found, this activity can be built up on the existing base.

2.7 R&D Support Program

TDC's R&D program requires substantial support services, including contracting services from Supply and Services Canada (SSC), a computerized management information system (MIS), a research library, and a publications and information dissemination unit. Over the three-year planning period, efforts will be made to offset personnel constraints with increased automation in order to maintain productivity. Support costs will be kept as low as possible, not exceeding 6 percent of the total R&D budget. The framework of the R&D support program is illustrated in Table 2.13. A new thrust area S150, R&D Assessment & Review, is added to reflect the constant demand placed on TDC to respond to such activities. The planned activity within each of these areas is described below. The planned activity levels for 1991-92 and the targeted levels for 1992-93 and 1993-94 are given in Table 2.14. The resources requirements for Automated Office and Management Systems and for the Research Library for 1991-92 appear low because funding was found in other O&M sources.

2.7.1 Supply and Services Canada Services

TDC uses SSC's contracting services almost exclusively for implementation of its R&D program. The level of SSC fees is based on the total contract value; depending on the size of the project, it varies between 3 and 4 percent of the contract value. Due to the reduction of TDPP funding, this service is primarily funded out of R&D Core and PERD Funds.

2.7.2 Automated Office and Management Systems

The computerized MIS facilitates timely and accurate monitoring, reporting, and financial control of TDC's activities. Over the years, TDC has developed a customized management system that supports effective financial and project management. TDC has completed the transfer of its MIS system to a new UNIX-based minicomputer. A microcomputer Local Area Network is being developed to link all technical staff to the MIS; eventually, all staff will have intelligent workstations linked to the central MIS data base for project management functions. Emphasis will be placed on proper system documentation for users and analysts alike.

2.7.3 Information Dissemination

An important element in TDC's research mandate is the dissemination of information on its research program, including the detailed technical data and results of its research activities. This information is documented in literature aimed at the general public and in scientific and technical reports distributed to specialized transportation and research audiences in both the public and private sectors. TDC publishes an

Table 2.13
R&D SUPPORT PROGRAM FRAMEWORK

R&D SUPPORT S100
SSC SERVICES S110
AUTOMATED OFFICE AND MANAGEMENT SYSTEMS S120
INFORMATION DISSEMINATION S130
RESEARCH LIBRARY S140
R&D ASSESSMENT AND REVIEW S150

Table 2.14
R&D SUPPORT
FUNDING REQUIRED FOR PLANNED ACTIVITIES 1991-92 — 1993-94

R&D OBJECTIVES	1990-91 \$000	1991-92 \$000	1992-93 \$000	1993-94 \$000
SSC SERVICES	333	380	410	430
AUTOMATED OFFICE AND MANAGEMENT SYSTEMS	185	35	208	230
INFORMATION DISSEMINATION	228	233	280	300
RESEARCH LIBRARY	183	12	193	210
R&D ASSESSMENT AND REVIEW	0	20	0	0
TOTAL	929	680	1 091	1 170

average of 130 titles every year; these include regular and special publications produced in-house by its Publications Unit and project research reports prepared for TDC by its research contractors. The Unit is staffed by a publications officer, with writing, English and French editing, and production support services provided through contracts. Over the planning period, the Unit's desktop publishing system will be evaluated with a view to enhancing its text and graphics integration capability.

2.7.4 Research Library

TDC's Judith Nogrady Library has one of Canada's finest transportation research collections, comprising government reports, books, journals, and extensive audio-visual holdings. The library staff is made up of a head librarian and other contracted personnel, who are responsible for building and maintaining the collection and providing a wide range of technical and reference services. These include maintaining a mailing list data base for the distribution of TDC publications; cataloguing and interlibrary lending using the UTLAS cataloguing support system; and bibliographic searching using the CAN/OLE and DIALOG on-line information retrieval systems. Access to the library's collection is available to all Transport Canada components, industry, academe, and other government departments.

2.7.5 R&D Assessment and Review

To maintain a high level of accountability and operational efficiency, TDC undertakes and responds to various internal assessments and procedural reviews. Resources for these activities are made available as required, primarily from Core R&D funds.

2.8 Canada-Quebec ERDA Sub-Agreement on Transportation Development

In December 1984 the federal government and the province of Quebec signed an Economic and Regional Development Agreement (ERDA). In July 1985 the two governments signed a \$170 million ERDA Sub-Agreement on Transportation Development that included \$15 million over five years for transportation R&D. The Agreement was to terminate on March 31, 1990 but has been extended to October 31, 1991. No new projects may be initiated after this date, but work in progress will be allowed to proceed until October 31, 1992. It is estimated that \$13 million of the total will be spent by October 1992 with \$700 000 being spent in this fiscal year.

Projects are funded equally by both governments. They must meet the objectives of the Agreement for the specified sectors, and be acceptable to both governments. Additionally, projects are generally cost-shared with industry. The total economic value of R&D activities initiated under this Agreement, including private sector cost-sharing, is in the order of \$30 million.

The Canada-Quebec ERDA program is intended to increase and accelerate transportation R&D in Quebec with the aim of maintaining and strengthening industrial capacity in this sector (one of the strongest in the Quebec economy), as well as increasing the efficiency and competitiveness of the transportation system by ensuring that it benefits from technological advances.

The program covers four main sectors:

- road transport system technologies;
- rail transport system technologies;
- transport micro-electronics and computerization; and
- intermodal transport (particularly in Montreal).

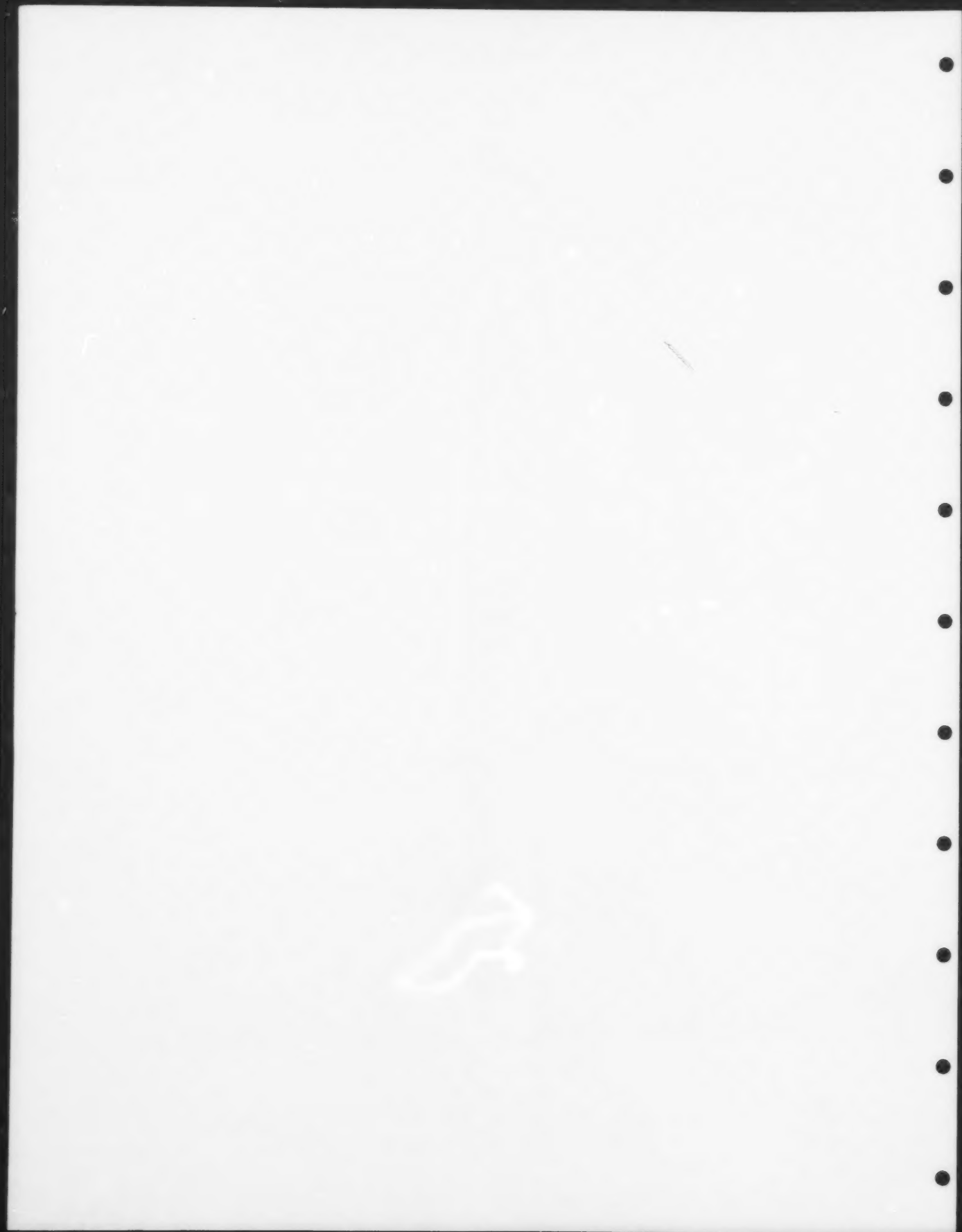
Initiatives undertaken include: an in-service demonstration of twelve Prévost articulated buses on Voyageur's Montreal-Quebec City route; a demonstration project for the use of natural gas on city buses; studies of truck transport, highway civil engineering, railway rolling stock technology, and computerized management of road traffic and infrastructure; demonstrations of accessible taxis to resolve access problems encountered by elderly and disabled persons; and testing of two prototypes of a fabricated railcar truck in commercial service with AmTrak.

The benefits of the ERDA program include not only the obviously useful research, development, and demonstration work, but also the excellent cooperation in R&D between Transport Canada and Transports Québec fostered by the Agreement. These successful exchanges may lead to further cooperative funding of promising R&D projects by Transport Canada and Transports Québec after October 1992, when the Agreement is no longer in force.

Table 2.15
CANADA-QUEBEC ERDA
FUNDING REQUIRED FOR PLANNED ACTIVITIES

R&D OBJECTIVES	1990-91	1991-92	1992-93	1993-94
	\$000	\$000	\$000	
TRANSPORTATION ACCESSIBILITY				NO FUNDS ALLOCATED
Accessible Taxi Demonstration	138	87		
HIGHWAY				
Salt Spreader	100	30		
Natural Gas Bus STCUM	43	15		
On-board Truck Scale	119			
New Salt Storage		125	125	
Highway Weather Monitor		75	75	
Analysis & Computerization at Highway Check Points		50	50	
Highway Test Equipment		0	0	
New Snow Plow		63	63	
Demonstration Articulated Auto Car — Phase II	49			
MULTIMODAL				
Traction Battery	131	100		
High-Capacity Subway Car Body	42			
RAIL				
M.O.Q. Rail Truck Convoy		128	334	
Fabricated Rail Truck	259			
TOTAL	881	673	647	





3. OBJECTIVES AND CURRENT YEAR TARGETS

3.1 Marine R&D Program

3.1.1 Regulation and Safety (M100)

Objective

To support the Canadian Coast Guard (CCG) in the development of regulations for the safe and efficient conduct of marine activities in waters under Canadian jurisdiction.

Sub-objectives

Arctic Ship Regulations (M110)

To support the development of Canadian Arctic Shipping Pollution Prevention Regulations in support of the CCG.

Current Targets

Initiate a study to collect and analyse propulsion trial results in support of revision of regulations.

Initiate work to ensure the availability of adequate hull monitoring systems.

Develop an initial data base pertaining to the plastic stability of ice-loaded structures.

Conventional Ship Regulations (M120)

To support the development of conventional shipping regulations by the CCG.

Current Targets

Continue with the evaluation of residual stability and subdivision for passenger ships, using a probabilistic approach.

Adapt low-maintenance component designs, from a previously developed life raft for small craft, for use in larger life raft designs.

Search and Rescue (M130)

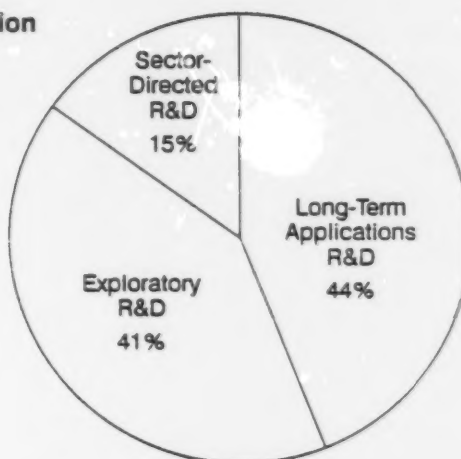
To support the development of techniques and technology to minimize search time and resource requirements and maximize the speed of CCG search and rescue operations.

Table 3.1
MARINE R&D PROGRAM FRAMEWORK

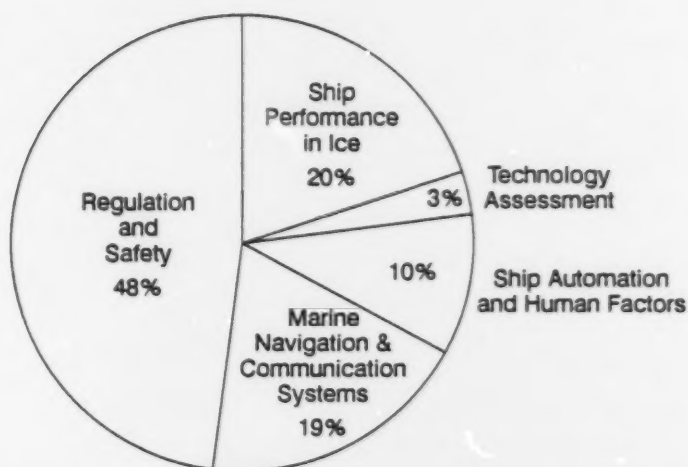
REGULATION AND SAFETY M100	SHIP PERFORMANCE IN ICE M200	MARINE NAVIGATION & COMMUNICATION SYSTEMS M300	SHIP AUTOMATION AND HUMAN FACTORS M400	TECHNOLOGY ASSESSMENT M500
ARCTIC SHIP REGULATIONS M110	PERFORMANCE PREDICTION IN ICE M210	NAVIGATION IN ICE (Commercial) M310	SHIP AUTOMATION AND CONTROL M410	EMERGING TECHNOLOGIES M510
CONVENTIONAL SHIP REGULATIONS M120	ICEBREAKING SHIP TECHNOLOGY M220	NAVIGATION IN ICE (CCG) M320	MARINE SIMULATION: HUMAN FACTORS M420	WEST COAST TUG AND BARGE M520
SEARCH AND RESCUE M130	FUTURE ICE-CAPABLE SHIPS M230	INSHORE NAVIGATION M330	CREWING: HUMAN FACTORS M430	MANOEUVRA- BILITY IN SHALLOW / CONFINED WATERS M530
MARINE SAFETY M140				
ENVIRONMENTAL PROTECTION M150				

Figure 3.1
MARINE R&D PROGRAM
SUMMARY OF RESOURCE ALLOCATIONS

TOTAL: \$3.5 million



Fiscal Year 1991-92
BREAKDOWN BY R&D CATEGORY



Fiscal Year 1991-92
BREAKDOWN BY R&D THRUST

OBJECTIVES AND CURRENT YEAR TARGETS

Current Targets

Complete a trial of forward-looking infrared equipment for search purposes.

Complete the study of a direct communication link between the Rescue Control Centre and the search and rescue units in an effort to centralize search and rescue operations.

Initiate the second phase of development of an expendable, active, air-droppable buoy to track surface drift in a localized search area.

Commence work on leeway drift of SAR objects in higher sea states.

Marine Safety (M140)

To support the development of improved techniques for crew safety and survival in the Arctic, and to improve CCG vessel traffic management technologies.

Current Targets

Continue work on Arctic mariner survival procedures, equipment, and equipment specifications based on previous trials.

Continue evaluation of research approaches for a prototype vessel-traffic management workstation.

Investigate the use of composite materials in buoy design.

Initiate work to develop a solar atlas for powering navigation aids.

Initiate the development of prototype radar signal processing equipment to provide for low cost backhaul of these signals to VTS centres.

Environmental Protection (M150)

To support the development of techniques and procedures for protecting the marine environment.

Current Targets

Continue work to identify available means for detecting and tracking oil spills, particularly submerged spills.

Initiate the development of a national marine spill response network.

Investigate the feasibility of a ship self-help system to contain an oil spill.

3.1.2 Ship Performance in Ice (M200)

Objective

To systematically foster technological improvement to the effectiveness, efficiency, productivity, and competitiveness of Canadian marine vehicles and to facilitate year-round access to Arctic hydrocarbon resources.

Sub-objectives

Performance Prediction in Ice (M210)

To examine the effects of operating in ice on ship resistance, propulsion, manoeuvring, and structural performance and to develop mechanisms to better understand the physical phenomena involved in ship-ice interactions.

Current Targets

Initiate the development of a concept design model for ship design.

Improve existing software tools for predicting icebreaker resistance.

Continue studies on propeller-ice interaction.

Continue research into ice modelling, including ice ridge models, to improve the ship model testing environment.

Investigate system identification techniques to derive full-scale ship performance data from simple, non-dedicated icebreaker manoeuvres.

Icebreaking Ship Technology (M220)

To develop means to improve the performance of icebreakers by developing a clearer understanding of the physical phenomena involved in icebreaking and by evaluating new developments in icebreaking technology.

Current Targets

Continue work on the use of waterjet technology for propeller protection.

Initiate work to examine the effects of hull friction on resistance.

Future Ice-Capable Ships (M230)

To develop techniques that will facilitate the design of safe, effective, and efficient large commercial tankers operating year-round in ice-infested East Coast waters or in the Arctic.

OBJECTIVES AND CURRENT YEAR TARGETS

Current Targets

Continue Arctic tanker hull form optimization studies for varying conditions of open water and ice.

Initiate a study on tanker risks inherent in Arctic voyages.

3.1.3 Marine Navigation and Communication Systems (M300)

Objectives

To provide systems contributing to safe and efficient all-weather navigation through ice-infested or ice-covered waters in the Canadian Arctic, and to facilitate access to Arctic hydrocarbon resources.

Sub-objectives

Navigation in Ice (Commercial) (M310)

To develop the Shipboard Integrated Navigation Support System (SINSS), including satellite links, synthetic aperture radar imagery, specialized ice radars and consoles, and other technology (such as sonar), for detection and display of hazards in ice-infested waters. The *M.V. Arctic* will be used as the test vessel.

Current Target

Carry out second generation SINSS development based on results from the functional specification study for ice navigation systems.

Navigation in Ice (CCG) (M320)

To develop all-weather navigation systems to improve CCG operational performance in ice-infested waters.

Current Target

Complete the testing phase for an electromagnetic ice-thickness sensor.

Inshore Navigation (M330)

To develop technology to improve all-weather navigation close to shore.

Current Target

Integrate the SINADS II and RANAV concepts and prepare for Arctic testing.

3.1.4 Ship Automation and Human Factors (M400)

Objective

To systematically improve selected ship systems and crew training technologies and to study the human factor implications of changing technologies aboard ship.

Sub-objectives

Ship Automation and Control (M410)

To systematically develop and study ship automation and control technologies in conjunction with users and to evaluate the potential of these technologies for in-service operational improvements.

Current Targets

Initiate a study on the use of performance analysis techniques in predictive maintenance for CCG vessels.

Complete the development of performance specifications for advanced machinery control systems for CCG ships and prepare for prototype design and testing.

Marine Simulation: Human Factors (M420)

To contribute technically and ergonomically to the development, utilization, and identification of the training potential of marine simulators operating in Canada.

Current Target

Related activities are under way in M140.

Crewing: Human Factors (M430)

To evaluate the effects of new technologies and policies on ships' crews in terms of effectiveness, influence on crew fatigue, training requirements, etc.

Current Target

Institute work to identify physical requirements for demanding jobs on board CCG vessels.

3.1.5 Technology Assessment (M500)

Objective

To carry out technology assessments and explore advanced concepts in support of governmental and commercial marine operations.

Sub-objectives

Emerging Technologies (M510)

To identify, monitor, and develop selected emerging technologies that promise to facilitate marine regulatory reform or to improve safety, design, performance, navigation capabilities, or ship operations.

Current Target

Investigate new materials and technologies for the marine environment.

West Coast Tug and Barge (M520)

To improve the safety, efficiency, and performance of commercial tugs and barges operating from Canada's West Coast.

Current Target

Carry out trials of an Arctic barge prototype.

3.2 Air R&D Program

3.2.1 Flight Safety (A100)

Objective

To develop expertise, techniques, and equipment to improve flight safety in the Canadian air transportation system.

Sub-objectives

Accident Prevention (A110)

To conduct research in support of technological and regulatory measures to reduce aviation accidents.

Current Targets

Continue work on the holdover time performance of Type II anti-icing fluids and the special requirements for commuter aircraft.

Monitor the international regulatory environment, and develop risk reducing countermeasures for take-offs from wet runways.

Plan research, related to ground deicing, into means of effectively communicating information on ground icing and aircraft condition to the cockpit crew.

Further develop a sensor to detect, identify, and measure a variety of materials that can contaminate aircraft surfaces.

Accident Survivability (A120)

To conduct research and develop techniques and equipment to improve accident survivability.

Current Targets

Continue evaluation of a new generation of Emergency Locator Transmitters (ELTs).

Investigate the feasibility of developing a fly-away ELT suitable for use in general aviation aircraft.

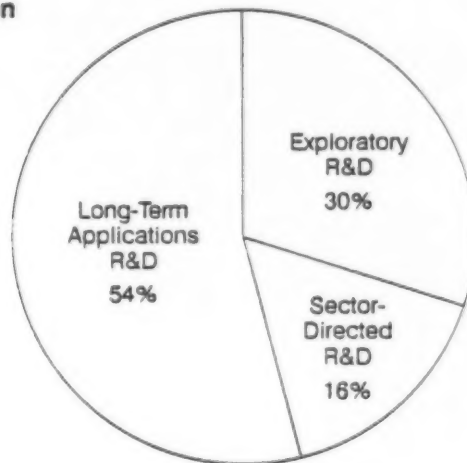
Table 3.2
AIR R&D PROGRAM FRAMEWORK

FLIGHT SAFETY A100	AVIATION SERVICES A200	AIRPORTS A300	ADVANCED CONCEPTS A400	SECURITY A500
ACCIDENT PREVENTION A110	WORKSTATIONS AND HUMAN-MACHINE INTERFACES A210	AIRPORT SECURITY A310	ADVANCED CONCEPTS AND TECHNOLOGIES A410	THREAT DETECTION A510
ACCIDENT SURVIVABILITY A120	AVIATION METEOROLOGY A220	OPERATIONS A320	INFORMATION DISSEMINATION A420	COUNTER-MEASURES A520
ACCIDENT INVESTIGATION A130	NAVIGATION AND COMMUNICATIONS AIDS A230	ENVIRONMENTAL IMPACTS A330	ENERGY CONSERVATION AND ENVIRONMENT A430	
MATERIALS AND STRUCTURES CERTIFICATION A140	DESIGN AIDS A240	RUNWAY DESIGN AND MAINTENANCE A340		
CREW TRAINING AND CERTIFICATION A150	FUTURE AIR NAVIGATION SYSTEMS A250		AIRCRAFT/ AIRPORT ACCESSIBILITY*	

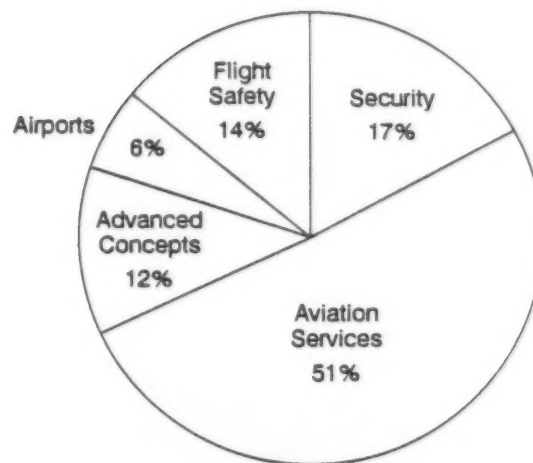
* Carried out under the Accessible Transportation R&D Program

Figure 3.2
AIR R&D PROGRAM
SUMMARY OF RESOURCE ALLOCATIONS

TOTAL: \$3 million



Fiscal Year 1991-92
BREAKDOWN BY R&D CATEGORY



Fiscal Year 1991-92
BREAKDOWN BY R&D THRUST

OBJECTIVES AND CURRENT YEAR TARGETS

Plan work on:

- 1) devices for improving detection of persons wearing life preservers floating in the water;
- 2) improved wear-resistant life preservers for continuous use in Canadian aircraft; and
- 3) acceptance criteria for infant restraint devices.

Accident Investigation (A130)

No activities this year.

Materials and Structures Certification (A140)

To investigate materials and structural design techniques to develop appropriate inspection, testing, and certification methods.

Current Target

Complete the investigation and definition of common principles to be applied to the certification of advanced composite components used for primary composite aircraft structures.

Crew Training and Certification (A150)

To develop tools, methods, and standards in support of regulations dealing with certification and crew training.

Current Target

Plan work on:

- 1) development of sourcebooks on sensory, cognitive, and motor limitations for application to pilot training; and
- 2) investigation of the effects of the glass cockpit, fatigue, and emergencies on pilot workload and operating skills.

3.2.2 Air Navigation Services (A200)

Objective

To develop expertise, techniques, and equipment in support of aviation services to improve the safety, capacity, and efficiency of Canadian air operations.

Sub-objectives

Workstations and Human-Machine Interfaces (A210)

To conduct research on workstations and human-machine interfaces in air traffic control system applications and develop improved equipment to reduce operator stress and increase system efficiency.

Current Targets

Continue the development of an advisory system, based on an expert systems approach, for traffic conflict avoidance in a medium-density radar environment.

Continue research on display technologies and ergonomic issues for ATC weather display.

Continue work on computer-assisted training workstations for electronics maintenance technicians.

Initiate a study of classroom/simulation/on-the-job transfer of training in the ATC training environment.

Aviation Meteorology (A220)

To conduct research and development on aviation meteorology to improve weather observation and prediction in support of the aviation community and to introduce new algorithms and technologies, including expert systems, to this domain.

Current Targets

Continue work on windshear analysis to assess the full extent of the problem in Canada and to devise algorithms to detect and predict microbursts.

Continue investigating the application of expert systems techniques to the forecasting of airport/terminal weather conditions.

Plan work on forecasting of icing conditions in the air and at ground level.

Navigation and Communication Aids (A230)

To develop navigation and communications expertise, techniques, and equipment in support of aviation services to improve the safety, capacity, and efficiency of Canadian air operations.

Current Targets

Complete the work on the tracking of a portable (extendable) MLS tower as a first step in the conceptual definition of a commissioning test set.

OBJECTIVES AND CURRENT YEAR TARGETS

Continue development of a level-3 MLS receiver design concept to establish the software requirements.

Plan work on innovative applications of MLS in Canada.

Design Aids (A240)

To facilitate the decision-making process in aviation services by improving design tools and data collection, processing, and analysis.

Current Targets

Continue development of a prototype system for designing airways and approach paths in computerized format.

Continue work on a computer-aided learning package for the Airspace Design Expert System (ADES).

Future Air Navigation Systems (A250)

To explore future air navigation systems and develop tools to define future system needs.

Current Targets

Provide Canadian contribution to international activities on future air navigation systems studies.

Plan work on:

- 1) current airspace criteria governing separation standards and the need for changes to allow for future segmented/curved instrument flight procedures.
- 2) the measurement, prediction, and display of wake vortex strength and position in order to reduce separation requirements.
- 3) environmental impact of aircraft NO_x emissions.

3.2.3 Airports (A300)

Objective

To develop expertise, techniques, and equipment in support of airport design and services, in order to improve the safety, capacity, and efficiency of Canadian air terminal operations.

Sub-objectives

Airport Security (A310)

To develop expertise, techniques, and equipment to reduce the effects of security measures on the efficiency of Canadian air transportation.

Current Target

Plan research into means of increasing the flow rate through security screening, including the evaluation of alternative configurations of screening stations at air terminals.

Airport Operations (A320)

To develop expertise, techniques, and equipment to support the design and management of Canadian airport operations.

Current Target

Plan work on:

- 1) continuing development of an airside planning model, based on the Vancouver and Toronto International Airports.
- 2) a user community help centre for SIMMOD (a simulation model) in Canada.
- 3) a smart card technology R&D program for airport applications.

Environmental Impacts (A330)

To investigate cost-effective methods of meeting the requirements for environmental protection related to airport construction and operation.

Current Targets

Complete the evaluation of sealing alternatives to resolve problems associated with highly acidic pyritic slate outcrops at Halifax International Airport.

Research the effect of strobe lights on airport bird control.

Plan work on:

- 1) issues associated with subsurface airport contaminants.
- 2) effects of Type II anti-icing chemicals on airport runoff.

OBJECTIVES AND CURRENT YEAR TARGETS

Runway Design and Maintenance (A340)

To develop expertise, techniques, and equipment in support of runway design, operation, and maintenance to improve the safety, capacity, and efficiency of Canadian airports.

Current Target

Plan work on:

- 1) expert systems for the maintenance of airport runways.
- 2) completion of the automated optical aircraft tracking system and a follow-up survey of the landing patterns of small aircraft to examine runway width requirements.

3.2.4 Advanced Concepts (A400)

Objective

To carry out technology assessments and explore advanced concepts in support of the Canadian air transportation system development.

Sub-objectives

Advanced Concepts and Technologies (A410)

To explore advanced concepts incorporating emerging technologies through feasibility studies and experimental testing.

Current Targets

Continue to monitor technological developments and explore vertiport concepts in anticipation of the introduction of civil tilt-rotor (CTR) aircraft.

Complete the vertiport study exploring new aircraft operating criteria and energy impacts of CTR intercity services.

Plan a CTR study in connection with a U.S./Canadian west-coast route network and with Canadian remote-area applications.

Information Dissemination (A420)

To participate in information dissemination activities and hold consultative workshops and symposia on air transport R&D.

Current Targets

Conduct a workshop on ground deicing issues following the 1991 Canadian Aerospace Sciences Institute annual general meeting.

Conduct a seminar on CTR developments in conjunction with the FAA/NASA CTR program group.

Undertake exploratory studies related to emerging technologies and advanced concepts in order to guide the department's long-range R&D program.

Energy Conservation and Environment (A430)

To investigate and foster development and application of technology to reduce energy consumption in Canadian-built aircraft in support of the objectives of the federal Energy Research and Development Program.

Current Targets

Continue work on computational aerodynamics methods to optimize air-frame system performance through improvement of intake/nacelle/propeller configurations.

Plan work on optimizing supercritical wing performance.

3.2.5 Security (A500)

To develop expertise, techniques, and equipment in support of security requirements to increase the safety of travellers using Canadian air transportation.

Threat Detection (A510)

To research innovative systems for detecting goods that present a threat to the safety of air travellers.

Current Targets

Continue work on a vapour preselector using laser technology for explosives sniffers.

Develop ion mass spectrometry explosives "sniffer" prototypes for field trials.

Plan work on a walk-through metal screening portal.

Countermeasures (A520)

No activities this year.

3.3 Highway R&D Program

3.3.1 Infrastructure (H100)

Objective

To undertake a selective research program in highway infrastructure that complements the initiatives of other government jurisdictions and the private sector and contributes to the achievement of federal government transportation objectives. The program is designed to promote a coordinated national approach to all research activities.

Sub-objectives

Cooperative National Programs (H110)

To undertake cooperative research with the provinces and with the Transportation Association of Canada (TAC) that addresses the design, construction, maintenance, rehabilitation, and operation of Canada's highway system in order to minimize total system costs.

Current Targets

Participate in the Canadian Strategic Highway Research Program (C-SHRP).

Support the R&D coordination activities of TAC and the TAC R&D Council.

Initiate a demonstration of highway weather monitoring systems, an ERDA project.

Initiate an evaluation of new storage facility and loading concepts for highway deicing products, an ERDA project.

Heavy Vehicle Compliance Technology (H120)

To stimulate applications of technology that will improve the accuracy and productivity of techniques for monitoring compliance with regulatory requirements; and to facilitate the effective management of heavy vehicles in the highway system.

Current Targets

Complete the original Canadian demonstration of an integrated system of weigh-in-motion, automatic vehicle identification, and communications technologies.

Initiate at least one follow-on project in the area of heavy vehicle electronic licence plate technology.

Participate in the planning of a program to demonstrate weigh-in-motion and automatic vehicle identification technology on Interstate Highway I-75 and its links in Ontario and Quebec.

Vehicle-Pavement Interaction (H130)

To explore the potential for integrated suspension and pavement design criteria through research on the relationship between suspension characteristics and pavement wear.

Current Targets

Complete the planning phase of a cooperative program to investigate the effect of heavy vehicle suspension design on pavement performance.

Initiate an evaluation of the various types of testing and research equipment for highway infrastructure, an ERDA project.

3.3.2 Truck Technology (H200)

Objective

To encourage improvements in the safety, productivity, and efficiency of highway freight transportation through research, development, and demonstration projects relating to vehicle technology, vehicle operations, and driver performance.

Sub-objectives

Transportation of Dangerous Goods (H210)

To develop methods, designs, and procedures for the safer and more efficient transportation of dangerous goods.

Current Target

Complete the planning for a demonstration of wide-area tracking and dispatching using two-way satellite communications.

Table 3.3
HIGHWAY R&D PROGRAM FRAMEWORK

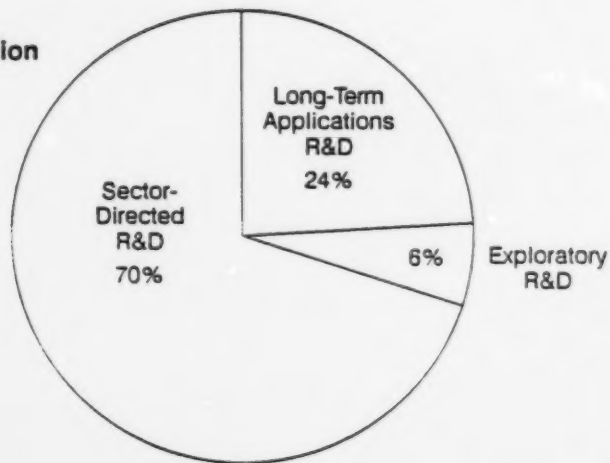
INFRASTRUCTURE H100	TRUCK TECHNOLOGY H200	BUS TECHNOLOGY H300	TECHNOLOGY EVALUATION AND PROGRAM PLANNING H400
COOPERATIVE NATIONAL PROGRAMS H110	TRANSPORTATION OF DANGEROUS GOODS H210	INTERCITY BUS TECHNOLOGY H310	SYSTEM EFFICIENCY AND PRODUCTIVITY H410
HEAVY VEHICLE COMPLIANCE TECHNOLOGY H120	HEAVY VEHICLE SAFETY H220	TRANSIT BUS TECHNOLOGY H320	TECHNICAL SUPPORT H420
VEHICLE - PAVEMENT INTERACTION H130	HEAVY VEHICLE TECHNOLOGY H230	INTERCITY BUS ACCESSIBILITY*	
	ENERGY CONSERVATION AND SUBSTITUTION H240	MULTIMODAL TRANSIT TECHNOLOGIES**	

* Carried out under the Transportation Accessibility R&D Program

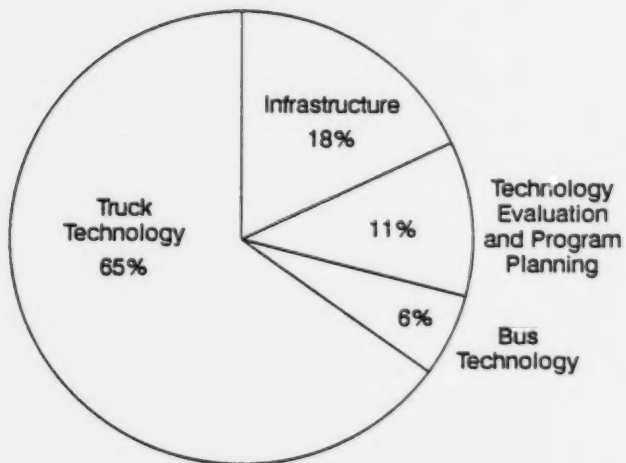
** Carried out under the Multimodal R&D Program

Figure 3.3
HIGHWAY R&D PROGRAM
SUMMARY OF RESOURCE ALLOCATIONS

TOTAL: \$2.2 million



Fiscal Year 1991-92
BREAKDOWN BY R&D CATEGORY



Fiscal Year 1991-92
BREAKDOWN BY R&D THRUST

Heavy Vehicle Safety (H220)

To advance research into freight vehicle technologies, human factors, and methodologies for accident data collection and analysis that will contribute to improved safety in highway transportation.

Current Targets

Continue the operational demonstration of antilock braking systems on B-train double tankers, a cooperative Canadian project complementing U.S. work by the National Highway Traffic Safety Administration.

Initiate an operational demonstration and evaluation of antilock braking and traction control systems on log trucks.

Initiate a field study on truck driver fatigue, a complementary project to U.S. work by the Federal Highway Administration (FHWA).

Participate in the FHWA study on the use of simulators in driver training and disseminate the results to the Canadian highway transportation community.

Continue the development of improved accident data analysis and forecasting techniques.

Continue the evaluation of technology options for the collection of motor vehicle accident data.

Initiate engineering design work on a truck rollover warning system.

Heavy Vehicle Technology (H230)

To promote the design and deployment of heavy freight vehicles that are safer, more productive, more efficient, and less damaging to the highway infrastructure.

Current Targets

Continue the development of IBM PC-compatible software to simulate and analyse the dynamics of combination vehicles.

Continue the cooperative program to develop, test, and demonstrate improved liftable axles for heavy vehicles.

Complete the program to develop a reduced axle weight salt spreader, an ERDA project.

Initiate an ERDA project to develop an improved, reduced-weight snow plow.

Initiate a cooperative investigation of logging truck stability, the performance of existing designs, and the potential for improvement.

Energy Conservation and Substitution (H240)

To undertake projects that support the objectives of the federal Energy Research and Development Program with respect to vehicle emissions, energy conservation, and the use of alternative fuels in highway transportation.

Current Targets

Continue work on the effects of vehicle-road-driver-environment relationships on heavy vehicle fuel consumption.

Implement an information dissemination program on the results of heavy vehicle fuel consumption research projects.

Initiate a comparative study on the energy usage and emissions of truck and rail freight transportation.

Initiate a project to develop an advanced design, energy-efficient trailer.

Continue the evaluation of a system to reduce the nitric oxides in diesel exhaust.

Continue the evaluation of diesel emissions from methanol fuel.

Initiate a project to develop an all-ceramic glow plug suitable for use in heavy-duty diesel and alternative-fuelled engines.

Complete the development of a kit to convert bus diesel engines to natural gas, an ERDA project.

Continue the program of R&D on new materials and testing procedures for vehicle on-board compressed natural gas fuel cylinders.

3.3.3 Bus Technology (H300)

Objective

To encourage the development of safer, more accessible, more productive, and more efficient buses.

Sub-objective

Intercity Bus Technology (H310)

To promote the design and deployment of safer, more accessible, more productive, and more comfortable intercity buses through the application of computer-aided design, the use of new materials, and technology transferred from more sophisticated areas.

OBJECTIVES AND CURRENT YEAR TARGETS

Current Targets

Complete the reporting on the Prévost articulated bus demonstration, an ERDA project.

Continue to demonstrate the prototype, 45-foot, accessible intercity bus to provincial authorities, major carriers, and consumer groups.

Complete the planning phase for a program to demonstrate a prototype multiplexing system on an intercity coach.

Transit Bus Technology (H320)

To promote the design and deployment of safer, more accessible, more energy-efficient and environmentally friendly transit buses.

Current Targets

Continue the development of a regenerative braking system for urban buses.

Initiate a study on the benefits and costs of advanced, low-floor transit buses.

3.3.4 Technology Evaluation and Program Planning (H400)

Objective

To investigate potential applications of emerging technologies to highway transportation; and to maximize the benefits of TDC's highway R&D by providing effective technology transfer and program planning.

Sub-objectives

System Efficiency and Productivity (H410)

To advance research into electronics and computer and communications technologies that will improve the efficiency and productivity of highway transportation.

Current Targets

Conduct a workshop to define Canadian needs in the area of intelligent vehicle-highway systems.

Initiate a demonstration of automatic vehicle identification technology for the control of taxi operations at a major airport.

Continue the development of demand forecasting models.

Technical Support (H420)

To provide technical investigation and engineering services in support of planning and implementation of new R&D activities; and to facilitate the exchange of information on highway R&D by organizing conferences and seminars.

Current Targets

Evaluate state-of-the-art technologies and adjust the long-term research program accordingly.

Provide additional technical expertise in support of current highway transportation R&D activities.

Participate in selected seminars and conferences.

3.4 Rail R&D Program

3.4.1 Regulatory Support (R100)

Objective

To increase safety in the railway sector through R&D support to the regulatory and inspection functions of the Surface Group of Transport Canada.

Sub-objectives

Transport of Dangerous Goods R&D (R110)

To increase safety in the transport of dangerous goods through R&D in support of the Transport Dangerous Goods Directorate of the Department's Surface Group.

Current Targets

Fire Safety Engineering

Complete development of a dynamic model of a pressure relief valve.

Carry out fire engulfment tests to determine the mode of failure, the severity of tank explosion or rupture, and the projectile hazards of tanks. Tanks in the 10 to 100 lb range will be tested.

Incorporate a thermodynamic model into the existing TANK CAR computer model to improve its usefulness as a predictive tool in evaluating tank protection systems.

Study alternatives to the use of methanol heaters in railway boxcars.

Initiate a research program on Boiling Liquid Expanding Vapour Explosions (BLEVEs) based on a review of initial studies carried out by the Transport Dangerous Goods Directorate.

Urban Area Rail Transport of Dangerous Goods

Complete the study initiated in 1990 on the effects of train speed on the probability of accidents involving the release of dangerous goods.

Initiate a second phase of the study of freight train marshalling practices as they pertain to the safe transport of dangerous goods.

Tank Car Design and Operations

Develop in conjunction with the Transport Dangerous Goods Directorate terms of reference for future projects in accumulation of product in thermal jackets of tank cars, improved loading and unloading practices and equipment for tank cars, and improved tank car timing inspection methods.

Initiate a project to define and develop concepts for tank cars of the future, the "Year 2020 Tank Car".

Emergency Response

Complete the electronic waybill study with an evaluation of legal implications of Electronic Data Interchange as a means of providing data for emergency response.

Continue work on terms of reference for a project to find a means of identifying pressure tanks as to type of lading and state of fill.

Initiate a project to identify a cold-tapping lading transfer technique suitable for use in emergency response situations.

Railway Safety R&D (R120)

To increase safety of railway operations through R&D in support of the Railway Safety Directorate of the Department's Surface Group.

Current Targets

Ergonomics

Complete the critical incidents study initiated in 1990.

Continue work on the MEG/EEG studies which are expected to finish in the fall of 1992.

Inspection and Non-Destructive Testing

Complete the study of the evaluation of technologies for wayside inspection of railway wheels for defects.

Crossing Safety

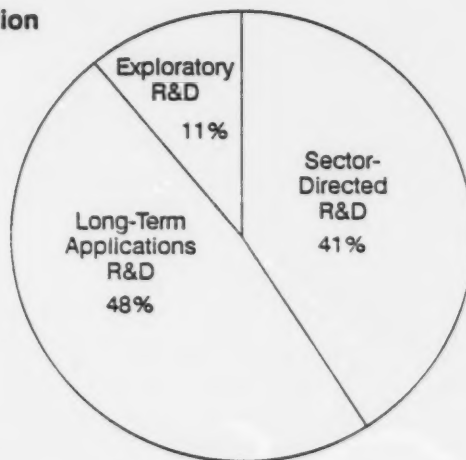
Develop terms of reference for a future project involving a TIES or standing offer arrangement for investigations related to level crossings.

Table 3.4
RAIL R&D PROGRAM FRAMEWORK

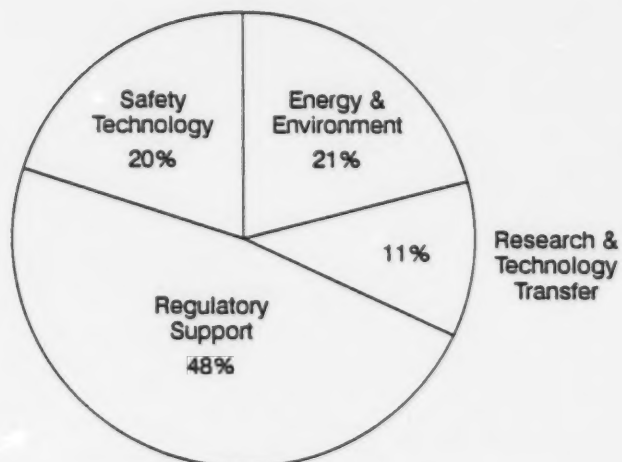
REGULATORY SUPPORT R100	SAFETY TECHNOLOGY R200	ENERGY AND ENVIRONMENT R300	RESEARCH AND TECHNOLOGY TRANSFER R400
TRANSPORT OF DANGEROUS GOODS R&D R110	ADVANCED TRAIN CONTROL SYSTEMS (ATCS) R210	ENERGY R310	RESEARCH R410
RAILWAY SAFETY R&D R120	SYSTEM SAFETY R220	ENVIRONMENT R320	TECHNOLOGY TRANSFER R420

Figure 3.4
RAIL R&D PROGRAM
SUMMARY OF RESOURCE ALLOCATIONS

TOTAL: \$1.2 million



Fiscal Year 1991-92
BREAKDOWN BY R&D CATEGORY



Fiscal Year 1991-92
BREAKDOWN BY R&D THRUST

3.4.2 Safety Technology (R200)

Objective

To enhance safety in rail transport through the conduct of cost-shared R&D with the private sector.

Sub-objectives

Advanced Train Control Systems (ATCS) (R210)

In cooperation with the railway sector, to promote and facilitate improved safety through the application of Advanced Train Control Systems.

Current Targets

Monitor the Industry, Science and Technology Canada (ISTC) ATCS program through an ad hoc Interdepartmental Committee, to ensure that the safety objectives of ATCS are effectively addressed.

Complete the project for design, development, and testing of a VLSI CODEC for application in ATCS. Ensure the technology transfer of this work.

Evaluate opportunities for cooperative projects with industry that will directly affect the safety benefits of ATCS. Initiate such projects, subject to availability of funds.

System Safety (R220)

In cooperation with the railway sector, to promote and facilitate the improvement of rail safety through application of new technologies.

Current Targets

Train Inspection

Evaluate, in cooperation with Canadian National Railways, an acoustic bearing defect detection system.

Signalling and Communications

Continue to look for opportunities to develop a system for monitoring compliance with speed restrictions and authority limits in signalled territory.

Complete the evaluation of guided radar as a means of detecting landslides obstructing track. There will be a milestone review in spring 1991 after which a decision will be taken on whether to continue development of the system.

Continue to support, in cooperation with railways, the Canadian Institute of Guided Ground Transportation in carrying out track structure research in the following areas:

- calibration of devices to measure dynamic wheel loads;
- impact tests conducted at various ambient temperatures on rail samples to determine their fracture toughness;
- development of a more economic wheel load measuring device to permit railways to expand data bases on dynamic wheel loads and use of this data to improve the planning of track maintenance.

Continue to support on a shared-cost basis, in cooperation with CP Rail, research on the following:

- investigation of the effect of residual stresses resulting from rail welding on the incidence of weld failure;
- characterization and improvement of flash butt shop welding practices used in rail stringing plants;
- field tests and computer studies to quantify vertical track impedance and correlate it with the occurrence of rail corrugation.

3.4.3 Energy and Environment (R300)

Objective

To support federal government policies and priorities in energy and the environment through R&D in rail transportation.

Sub-objectives

Energy (R310)

To support the transportation objectives of the federal Energy Research and Development Program:

- identification and use of the most suitable fuels for each transportation mode (alternative fuels);
- more efficient transport of coal (coal transportation).

OBJECTIVES AND CURRENT YEAR TARGETS

Current Targets

Alternative Fuels

Complete a study to determine the feasibility and benefits of embarking on a project to research alternative fuels using a two-stroke single cylinder engine. Initiate further work depending on the results of the feasibility study.

Consult with interested groups respecting a study of road and rail mode energy use and emissions. Depending on the results of these consultations, initiate a study in cooperation with the road mode interests.

Coal Transportation

Continue evaluation of the performance of the low-tare aluminum coal car in unit-train coal service with CP Rail.

Review and act on proposals for further evaluation of radial trucks.

Continue wheelset testing on the NRC wheel/rail system test rig to establish fundamental performance characteristics of heavy-haul wheelsets at various loads and angle-of-attack settings.

Environment (R320)

To support the federal government's policies with respect to the environment, as they affect the rail transportation system.

Current Target

Continue discussions with Environment Canada and the railway industry with a view to initiating research on locomotive emissions.

3.4.4 Research and Technology Transfer (R400)

Objective

To carry out applied research that will provide long-term benefits to the Canadian railway system and, through activities in the area of technology transfer, to ensure the application of the knowledge generated through the TDC Rail R&D Program.

Sub-objectives

Research (R410)

To provide scientific and technical knowledge in support of the needs of Transport Canada and the long-term development of the Canadian railway system.

Current Targets

Non-Destructive Testing

Continue assessment of non-destructive techniques for residual stress measurement.

Carry out a cost-shared project to investigate the potential of forced-response vibration techniques to estimate thermal stresses in rail.

Rolling Contact Mechanics

Continue work with NRC on the investigation of corrugation formation.

Materials Technology

Continue work on the use of thermally sprayed advanced material coating technology for coating diesel engine cylinder liners.

Technology Transfer (R420)

To transfer technology for the benefit of the Canadian railway system through activities and research linking the TDC program to national and international R&D.

Current Targets

Continue support for the secretariat functions of the RRAB.

Initiate a pre-feasibility study on the establishment of a Railway Management Training Institute in Canada.

Organize meetings, seminars, and workshops in cooperation with other organizations, to enhance the effectiveness of the rail program.

3.5 Multimodal R&D Program

3.5.1 Technology Transfer (I100)

Objective

To maintain and enrich TDC's technical base of expertise and to promote transfer of knowledge from enabling disciplines to transport applications through seminars, personnel exchanges, symposia, and workshops.

Sub-objectives

Visiting Experts Program (I110)

To maintain a visiting experts program at TDC on a three-year trial basis from 1 April 1989 to 31 March 1992.

Current Targets

Maintain the program using established procedures for identifying, approving, and contracting appropriate candidates.

Contract at least one visiting expert during 1991-92.

Technical Seminars and Studies (I120)

To organize technical seminars and workshops on technology issues and disciplines relevant to more than one mode of transport.

Current Targets

Implement a project for R&D planning support.

3.5.2 Technology Monitoring (I200)

Objective

To monitor developments in transport technologies of possible future importance to the department although not currently its direct responsibility. The intention is to understand the safety, productivity, cost-effectiveness, and environmental effects of these systems so as to advise Transport Canada on policy issues.

Sub-objectives

Transit and Traffic Technologies (I210)

To monitor developments in transit and traffic technologies in collaboration with the Canadian Urban Transportation Association (CUTA) and other organizations involved in this area.

Current Targets

Render financial and technical support to CUTA's strategic national urban transit R&D program.

Continue to support the CUTA secretariat for R&D coordination.

Complete the Integrated Traffic System demonstration in several Ontario municipalities in cooperation with the Ministry of Transportation of Ontario.

Obtain the Stanford Research Institute Technology Monitoring services.

Non-Conventional Transportation Systems (I220)

To monitor developments in non-conventional transportation systems so as to understand their potential impact, and to evaluate applications of appropriate technologies in Canada.

Current Targets

Maintain a watching brief on Maglev transportation systems, off-road transport technology, and solids pipelines.

Continue development of an advanced linear induction motor (LIM) control system.

Complete methodology for establishing and documenting standards, ratings, test procedures, and analysis methods for linear electric drives.

Environmental R&D Support (I230)

To ensure minimum negative effects of transportation operations to users, surrounding populations, and the environment, while improving the safety and cross effectiveness of these operations.

Current Targets

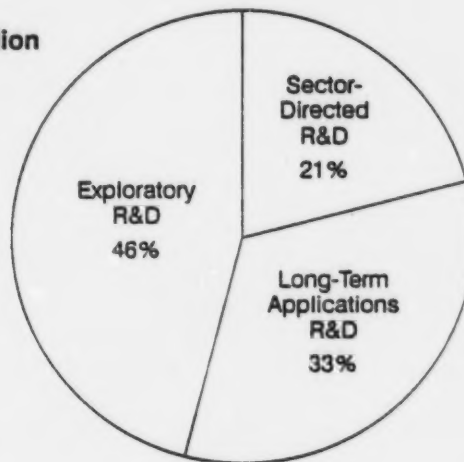
Maintain a multidisciplinary consulting capability able to respond rapidly to a range of environment-related R&D requirements.

Table 3.5
MULTIMODAL R&D PROGRAM FRAMEWORK

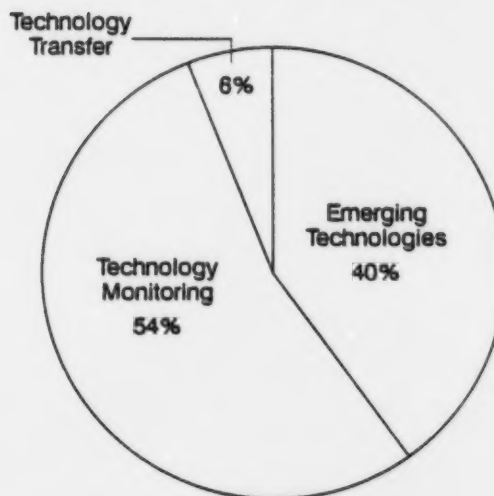
TECHNOLOGY TRANSFER I100	TECHNOLOGY MONITORING I200	EMERGING TECHNOLOGIES I300
VISITING EXPERTS PROGRAM I110	TRANSIT AND TRAFFIC TECHNOLOGIES I210	SATELLITE LOCATION AND NAVIGATION I310
TECHNICAL SEMINARS AND STUDIES I120	NON- CONVENTIONAL TRANSPORTATION SYSTEMS I220	MONOLITHIC MICROWAVE INTEGRATED CIRCUITS I320
	ENVIRONMENTAL R&D SUPPORT I230	SPEECH RECOGNITION AND SYNTHESIS I330
	HUMAN FACTORS I240	OTHER NEW TECHNOLOGIES I340

Figure 3.5
MULTIMODAL R&D PROGRAM
SUMMARY OF RESOURCE ALLOCATIONS

TOTAL: \$0.8 million



Fiscal Year 1991-92
BREAKDOWN BY R&D CATEGORY



Fiscal Year 1991-92
BREAKDOWN BY R&D THRUST

OBJECTIVES AND CURRENT YEAR TARGETS

Assess alternative technologies and systems for handling waste from Dorval and Mirabel international airports and from the Port of Montreal.

Initiate the development of a dangerous goods advisory system.

Explore methods of risk assessment for hazardous wastes.

Human Factors (I240)

To consider human factors in the design of transportation equipment and systems so as to optimize the safety, productivity, and capacity of the hardware and the performance of the user.

Current Targets

Maintain a consulting capability able to respond to ergonomic R&D requirements.

Conduct human factors R&D follow-up research as directed by the R&D Council.

3.5.3 Emerging Technologies (I300)

Objective

To undertake long-term development of key emerging technologies with potential for enabling major improvements to the transportation system and to Transport Canada's operations.

Sub-objectives

Satellite Location & Navigation (I310)

To undertake research on satellite location and navigation in response to specific Canadian transportation requirements.

Current Target

Organize a seminar on radio-navigation technologies for multimodal applications.

Monolithic Microwave Integrated Circuits (MMIC) (I320)

To undertake a multi-year development program to establish a capability in Canada for producing monolithic microwave integrated circuits; to develop a MMIC chip for application in a microwave landing system (MLS); and to test MMIC in trial operation.

Current Target

Evaluate feasibility of Phase 3 MLS Module Integration.

Speech Recognition and Synthesis (I330)

To establish a Canadian capability in speech recognition and synthesis and to apply this technology toward improved efficiency of Transport Canada's operations.

Current Target

Complete the Integrated Transportation Information System (ITIS) application project in Victoria, B.C.

Other New Technologies (I340)

To undertake development of other enabling technologies considered to have important potential benefits for transportation. These technologies include, but are not limited to, linear electric motors, advanced batteries, and superconductivity.

Current Targets

Participate in the Defence and Civil Institute of Environmental Medicine project with CTF Systems to develop a 60-channel magnetoencephalography system and test its effectiveness in measuring effects of stress.

Complete the development of a polymer electrolytic cell suitable to traction battery application.

Continue the study on fuel cell applications for Transport Canada.

Enlist expert advice on battery and electric vehicle technology.

Continue investigation into fuel cell and battery hybrid systems.

Continue study on hybrid-electric propulsion.

Complete neural network R&D program definition.

3.6 Transportation Accessibility R&D Program

3.6.1 System Accessibility (E100)

Objective

To foster the development of technology in the form of equipment, systems, and procedures to enable elderly and disabled persons to have access to transportation services in Canada, with particular emphasis on federally regulated modes.

Sub-objectives

Aircraft and Airports (E110)

To aid in the development and evaluation of accessible aircraft, transfer chairs/vehicles, and terminals, with emphasis on level change technologies.

Current Targets

Complete the demonstration and evaluation of selected aircraft boarding systems.

Complete a video describing procedures and equipment used for wheelchair loading.

Marine Vessels (E120)

To aid in the development and evaluation of accessible ferries.

Current Target

Complete the monitoring and evaluation of the newly installed elevator systems, designed to overcome level change barriers, on board the *M.V. Prince Edward* during the 1991 operating season.

Intercity Bus (E130)

To contribute to the improvement in equity and accessibility of the transportation services provided by intercity buses.

Current Targets

Continue the three-year demonstration of fully integrated, accessible bus service on Canada Coach Line's main corridor through Hamilton, Ontario.

Complete the ergonomic assessment of intercity bus washrooms on board the accessible 45-foot bus.

Access and Egress Modes (E140)

To aid in the development and evaluation of accessible vehicles and transit services (automobiles, taxis, etc.)

Current Targets

Continue the accessible taxi demonstrations with the province of Quebec.

Complete evaluation of the Ottawa accessible taxi demonstration project.

Perform paratransit driver task analysis.

Complete demonstration of HandyLine system to enhance customer information services and cost-effectiveness of HandyDart systems.

Investigate development of an accessible low-floor urban bus.

3.6.2 Safety (E200)

Objective

To improve the safety of elderly and disabled travellers in vehicles, terminals, and ways.

Sub-objectives

Wheelchair Passengers (E210)

To minimize the inconvenience and risk of travelling for wheelchair passengers.

Current Target

Continue the effort with provinces, CUTA, and CSA to develop standards for vehicles, mobility devices, and occupant protection.

Elderly and Disabled Drivers and Pedestrians (E220)

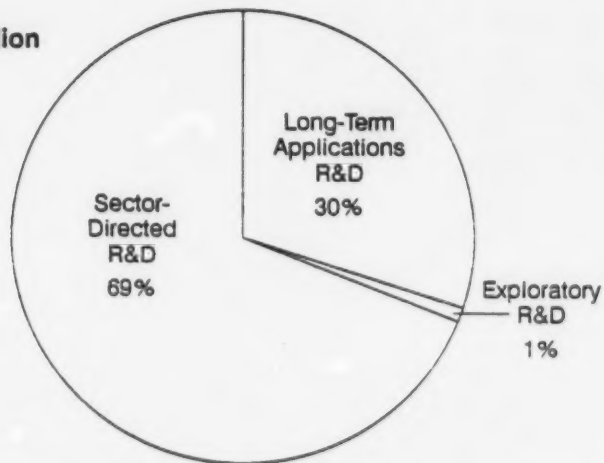
To enhance the safety of elderly drivers and pedestrians through adaptations of new and existing technologies.

Table 3.6
TRANSPORTATION ACCESSIBILITY R&D PROGRAM FRAMEWORK

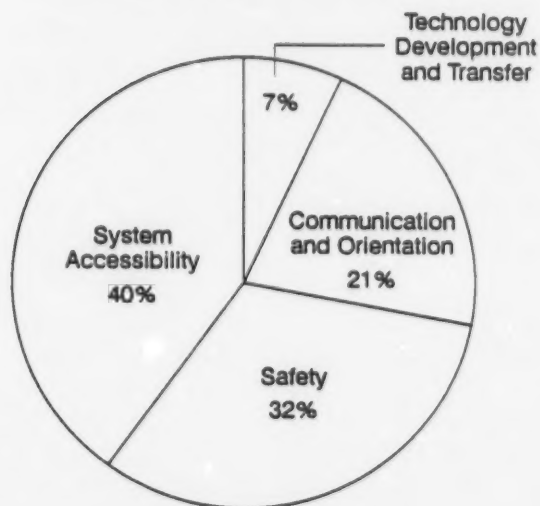
SYSTEM ACCESSIBILITY E100	SAFETY E200	COMMUNICATION AND ORIENTATION E300	TECHNOLOGY DEVELOPMENT AND TRANSFER E400
AIRCRAFT AND AIRPORTS E110	WHEELCHAIR PASSENGERS E210	SIGHT AND HEARING IMPAIRED TRAVELLERS E310	ENABLING TECHNOLOGIES AND DISCIPLINES E410
MARINE VESSELS E120	ELDERLY AND DISABLED DRIVERS AND PEDESTRIANS E220	COGNITIVELY IMPAIRED TRAVELLERS E320	TECHNOLOGY SUPPORT AND INFORMATION TRANSFER E420
INTERCITY BUS E130			
ACCESS AND EGRESS MODES E140			

Figure 3.6
TRANSPORTATION ACCESSIBILITY R&D PROGRAM
SUMMARY OF RESOURCE ALLOCATIONS

TOTAL: \$0.8 million



Fiscal Year 1991-92
BREAKDOWN BY R&D CATEGORY



Fiscal Year 1991-92
BREAKDOWN BY R&D THRUST

OBJECTIVES AND CURRENT YEAR TARGETS

Current Targets

Continue the development of the assessment module of a driving simulator for brain-damaged individuals.

Complete the exploratory study on potential applications of advances in micro-electronic technologies to the operation of private vehicles by elderly and disabled travellers.

3.6.3 Communication and Orientation (E300)

Objective

To eliminate travel barriers in all modes for the elderly and disabled traveller and to develop alternative designs or procedures facilitating travel, with emphasis on communication and orientation systems.

Sub-objectives

Sight and Hearing Impaired Travellers (E310)

To facilitate travel for sight or hearing impaired travellers through adaptation of new and existing technology.

Current Targets

Demonstrate and evaluate the subway in-vehicle information system (ICISS) in Montreal for use by sight and hearing impaired travellers.

Implement demonstration of Translaid, a communication system for persons with hearing loss or speech impediments.

Continue study on technology and systems, as well as on operational and procedural requirements for sight and hearing impaired travellers in transportation vehicles.

Complete the refinement of Communicaid II.

Cognitively Impaired Travellers (E320)

To facilitate travel for cognitively impaired travellers through adaptation of new and existing technology.

Current Target

Explore follow-on work to problem definition relating to the cognitively impaired.

3.6.4 Technology Development and Transfer (E400)

Objective

To assess and develop technologies in support of R&D activities; and to disseminate information to a wide audience of researchers, providers of services, policy makers, and consumers.

Sub-objectives

Enabling Technologies and Disciplines (E410)

To investigate methods and technologies to provide increased levels of safety for elderly and disabled travellers, pedestrians, and drivers.

Current Target

Explore use of CAD tool for planning of accessible systems and services.

Technology Support and Information Transfer (E420)

To disseminate information to a wide audience of researchers, providers of services, policy makers, and consumers.

Current Targets

Participate in conferences, workshops, and exhibits; organize seminars on personal mobility and automobile access.

Plan for the Driver Trainer Workshop in cooperation with the Hugh McMillan Medical Centre to be held in 1992-93.

Continue technical investigation and engineering services (TIES) and disabled consumer consultation and communication support contracts.

Complete the data base study on elderly and disabled Canadians.

Complete the development of a training package to familiarize taxi drivers with effective ways of dealing with disabled passengers.

3.7 R&D Support

Objective

To provide the necessary technical support for the planning, implementation, monitoring, evaluation, and information dissemination of TDC's R&D program.

Sub-objectives

Supply and Services Canada Services (S110)

To provide contracting services through Supply and Services Canada (SSC) for implementation of TDC's R&D program.

Current Target

Recoup a proportionate amount of SSC fees from the Energy Research and Development Program.

Automated Office and Management Systems (S120)

To develop and maintain computerized office systems at TDC, including a Management Information System (MIS), which facilitate timely and accurate monitoring, reporting, and financial control of TDC's R&D program.

Current Targets

Maintain the operation of the MIS and provide support to Financial Services.

Continue to update the bilingual MIS user's manual.

Continue the development of Local Area Network (LAN) operations at TDC.

Provide training and support in the use of microcomputers and microcomputer networks at TDC, including the update of on-line user support manuals.

Information Dissemination (S130)

To produce technical reports, general information publications, exhibits, audio-visual presentations, and alternative media materials providing information on TDC's research program; to participate in exhibitions and other communications-related activities.

Current Targets

Provide technical writing support for in-house documents, e.g. *TDC Annual Review*, *Selected R&D Achievements*, and *R&D Update*.

Provide word processing/desktop publishing services, English and French editorial services, and graphic arts services in support of Publications Unit activities.

Research Library (\$140)

To provide a full range of library services, including current awareness services, on-line information retrieval, an audio-visual collection, and access to a transportation research collection of documents developed to support TDC's R&D activities; and to maintain the mailing list system for the distribution of TDC publications.

Current Targets

Keep a watching brief for an on-line catalogue system with full string search and Boolean search capabilities as well as scrolling print-out or present features.

Continue to access the DIALOG and CAN/OLE systems for on-line information retrieval.

Continue to participate in the UTLAS cataloguing support system.

Continue management of research information support services.

R&D Assessment and Review

To evaluate TDC's R&D Program by means of technical, organizational, and role assessment.

Current Targets

To participate in the R&D Review and Evaluation initiated by the Transport Canada Review Group.

To undertake an assessment of the Increased Ministerial Authority and Accountability and Special Operating Agency concepts.

Table 3.7
R&D SUPPORT PROGRAM FRAMEWORK

R&D SUPPORT S100
 SSC SERVICES S110
 AUTOMATED OFFICE AND MANAGEMENT SYSTEMS S120
 INFORMATION DISSEMINATION S130
 RESEARCH LIBRARY S140
 R&D ASSESSMENT AND REVIEW S150

3.8 Canada-Quebec ERDA Transportation Sub-Agreement

The specific objectives of projects supported by ERDA funds are described in the appropriate operational program area objectives in this publication.

Current Targets

Monitor and direct work on ongoing projects in cooperation with Transports Québec. This work encompasses:

Accessible Transportation R&D Program Area

- Accessible taxi demonstration (E140)

Highway R&D Program Area

- Pilot demonstration of a system for the prediction of road conditions (H110)
- Pilot project on the design of new storage facilities for deicing materials (H110)
- On-board truck scale, 2 projects (H120)
- Evaluation of testing and research equipment for road infrastructure (H130)
- Electronic log book for trucks (H220)
- Design and development of a single-sided, side-winged snow plow (H230)
- Reduced weight salt spreader (H230)
- Natural gas for buses (H240)
- Reporting on articulated bus demonstration (H310)

Multimodal R&D Program Area

- Traction battery (I440)

Rail R&D Program Area

- MOQ Rail truck convoy